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Comparison of the Merits of the Mode of Building Iron Truss Bridges in America with the System Used in Europe.

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[Concluded from page 140.]

[Translated with additions by the author from the *Zeitschrift des Vereins deutscher Ingenieure.*]

The deflection of riveted girders, when by proper experiments the moduli of its iron have been previously established, can be derived from the theory of flexure, which is known to be reliable when applied to plain rolled pieces. But if the riveted girder is brought into the testing machine, and if its deflections are found to be larger than anticipated, then the conclusion is obvious that the connections of the pieces constituting the girder do not correspond with the scientific suppositions.

The ratios between the permanent and the elastic deflections, under these circumstances, form a scale by which to measure the effectiveness of the construction.

Thirteen years ago, at Phœnixville, many tests on flexure were made with riveted and at the same time with solid beams, rolled by Mr. Griffen's then newly invented piles. These experiments were intended to furnish reliable data of comparison which should establish the degree of perfection of manufacture, and were carried out with great painstaking by Mr. George Walters.

The results being of great regularity, it is sufficient for the present purpose to select but a few for comparison.

The riveted girders were 15 inches deep and 33 feet long, and were composed of two chord-bars rolled for such purposes in the shape of T iron, each of 6⅔ square inches section, and of 4 6-inch by ⅛-inch plates forming the web. The flat bars were riveted to both sides of the web of the T pieces, and in the centre were joined by a strip of 3⅛ × ⅛ inch, which was intended to take up the longitudinal shearing strains. A load of 10 tons gave a deflection of 1.896 inches, of which 0.298 inch was permanent.

From this result we calculate a total modulus of 21,500,000 lbs., while the modulus due to the elastic deflection was nearly 26,000,000 lbs. The maximum strain per square inch is calculated at 25,000 lbs.

Again, a 15-inch rolled beam of a weight per foot equal to that of the built girder, also under a load of 10 tons in the centre, deflected 1.309 inches, of which 0.129 inch remained permanently. From these results we derive the total modulus of 23,100,000 lbs., while the elastic modulus was 25,650,000 lbs., the maximum strain being 24,800 lbs. per square inch. A comparison of both series shows that though the strains per square inch in both experiments were nearly equal, the riveted girder gave a permanent set twice as large as the rolled beam, and the original modulus in the first case was reduced 21 per cent. but in the test of the rolled beam only 11 per cent., so that the ratio of values of both girders, according to the experiments, may be set down as

121:111; or as 109:100.

These results would indicate that riveted girders of the best arrangement, with sufficient thickness of web, such as seems desirable in order not to overstrain the iron in the rivet-holes, and such as could be used for stringers and cross bearers of bridge floors, should be constructed at least 10 per cent. stronger than rolled girders, while this percentage does not even include the loss of strength by loosened head-friction under vibrations, which must be expected to diminish the effectiveness materially.

The experiments on the Conway tubular bridge showed greater deflections than could justly be expected according to the reported modulus of the iron, while most probably the moduli of the large bridge plates and angles were even higher than the figures derived from previous experiments.

According to the data furnished by Mr. Edward Clark's work, the subsequent figures are materially correct:

Load per foot.	Pounds.	Deflection.	Modulus.	Reduction from original modulus.
Permanent.....	7,000	1-600 of span	19,400,0.0	25 per cent.
Permanent load plus 3 500 lbs...	10,500	1-436 of span	17,000,000	42 per cent.

The strains under the last load were but little higher than the maximum strain for which the bridge was calculated, and of course were far within the limit of elasticity of the iron. A rolled beam under such strain would not have shown any appreciable permanent set, and the modulus would not have been modified at all.

This is an unsatisfactory result, and does not agree with Mr. Edward Clark's sanguine expectations of being able to produce riveted work which would deflect precisely as if it were one welded piece. (Page 396, Vol. I.. of his work.)

General Morin, who reviews the experiments mentioned in his work (page 23, Vol. II.), notices this great flexibility of the joints and the insufficient correspondence with the theory established for solid beams, and he finds occasion for the following remark:

"This [the small modulus of elasticity of the riveted Conway bridge] does not appear to me to be due to the nature of the material used, which must have been noticeably softer than that of the previous experiments. It seems to me more probable that this great flexibility arises from the multiplicity of connections, which it is *impossible* to make *precisely alike*, and some of which *always are more strained than the others, and therefore yield first.*"

Experiments which M. Morin carried out on *open riveted girders*, which will be treated hereafter with reference to rupture, under strains of 20,000 pounds gave deflections *three* and *four* times as large as those under which the elasticity of good iron begins to alter. These insufficient results have forced the famous General to the following conclusions:

1. That combinations of this class, in consequence of the flexibility of their connections *neither* in regard to resistance against flexure *nor* against rupture can be put on the same level with continuous solid bodies, as a boiler-plate girder on double T beam, in which *all parts* are well connected (sont solidaires) and under flexure take part in developing forces by *molecular* reaction.

2. That the static considerations of decomposition of forces, which are sufficiently correct for simple solids, are much *less reliable when applied to complicated pieces with numerous connections*, whose PARTICIPATION IN THE TRANSMISSION of strains may BY CHANCE receive IMPORTANT MODIFICATIONS.

3. And that pieces of this kind are not at all capable of carrying loads as considerable as those which are derived from static calculations.

We shall now proceed to the results of experiments on rupture.

In this regard the tests of the model tube can be used, which preceded the construction of the English tubular bridges.

This tube certainly was composed of good, and, on account of its small thickness, also of very strong iron; it was manufactured with great care, and broke nearly every time in the *lower* chord, which originally was too weak and was finally increased to nearly the section of the top-chord. In the calculations of average strains, Mr. Edward Clark has left out the result of one experiment, which, though near to the average of the others, seemed to him too low; but Mr. Clark has used one which is so close to the breaking strain of the iron and so far from the average of the other experiments as to appear untrustworthy. Without this experiment the average breaking tensile strain is 34,800 lbs. per square inch, the lowest result giving 31,500 lbs.

The experiments on the class of iron used in the construction gave ultimate strains of 24 tons, and for plates, 20 tons; but since the iron used in the tube was much thinner and contained a good portion of angles, it will be perfectly safe to put its strength at 22 tons at least, or 49,300 lbs.

If we only judge it at this rate of strength, there is a loss connected with the construction of from 30 to 37 per cent. of the calculated strength of the cross-section, the rivet-holes being deducted. But it must not be forgotten that no cost had been spared to prepare the rivet connections perfectly: they were arranged double-shearing in the joints, and contained a great number of comparatively large and easily driven rivets, so that we arrive at the conclusion that according to these *experiments* the *very best rivet connections* are at least 30 per cent. below the strength which engineers were accustomed to expect from the rules derived from Mr. Fairbairn's experiments on a small scale, and by which the hope had grown up that it would be possible to utilize the full net section of iron applied for bridges and similar structures.

It might be rejoined that the chords of a tubular bridge receive greater strains in the connections with the webs, and that the result would be more favorable if experiments were made with a well-built model of a riveted lattice girder.

But we also will soon see that these results are still about the best that have come to our knowledge.

The younger Brunel carried out experiments with a boiler-plate girder, 66 feet long and 10 feet deep, whose web was ¼-inch thick, each of the chords having 25 in. section.

The iron of the bottom chord is reported to have been of *unusually* good quality, which, if assumed at only 45,000 lbs., experienced a loss of 33 per cent. of the strength of its net area.

The web of this beam, it appears, was far too light, and if made more in accordance with *acting* forces, a better result might have been obtained and the loss probably could have been reduced to 20 per cent.

General Morin made experiments with two open girders (mentioned above) of 16 feet length and 40 in. depth, which were intended for use on the French Southern Railroad. Each chord was composed of 2 4 in. angles; the web diagonals were arranged compressively; the verticals were designed for tension. Both girders broke, as is usually the case, in the lower chord under 25,800 to 26,800 pounds of strain on the square inch of net area.

These experiments show a loss of 45 per cent. if the strength of the angles is put down at the low rate of 45,000 lbs. per square inch.

Experiments on impacts will now be quoted, which Mr. Fairbairn made on a riveted girder; one million deflections under small strains having had no visible effect, a strain of 9.36 tons per square inch broke the piece—by tension—after only 5,175 repetitions.

The girder was patched and the experiments were continued, at first under lower strains, up to six tons; but the strain being raised to eight tons, the girder broke again after 313,000 deflections.

Mr. Stoney and others have drawn rather broad conclusions from these experiments. A comparison, however, with the very extended experiments of the German engineer Woehler will show what degree of durability might have been expected. The following table contains only a small portion of his valuable results.

The experiments were made on metals furnished to the railway, and the specimens were cut from axles, picked out of the stock furnished two years before the experiments were begun:

I. *Torsional experiments on iron furnished by the Phœnix Company in Ruhrort.*

The bars were twisted forward and backward, each particle being alternately strained by tension and by compression:

Direct strains per square inch.

+ 35,700 lbs.	broken after	50,400	repetitions.
+ 33,000 "	" "	99,900	"
+ 28,600 "	" "	479,490	"
+ 26 400 "	" "	909 810	"
+ 24,200 "	" "	3,602,588	"
+ 22,000 "	" "	4,917,992	"
+ 19,800 "	" "	19,186,791	"
+ 17,600 "	not broken after	132,250,000	"

The last result corresponds with a direct strain of 35,200 lbs., which was too low to produce rupture after more than 132 millions of repetitions.

II. *Experiments on* FLEXURE *in* ONE *direction*, on the same class of iron.

Direct strain per square inch:

+ 60,500 lbs.	broke tensionally after	169,750	deflections.
+ 55,000 "	" "	420,000	"
+ 49 500 "	" "	481,950	"
+ 44,000 "	" "	1 320,000	"
+ 39,600 "	" "	4,085,400	"
+ 35,200 "	" "	3 420,000	"
+ 33,000 "	did not break after	48,200,000	"

III. *The same iron under repeated* EXTENSIONS:

Strain 52,800 lbs.	broke after	800	extensions.
" 48,400 "	" "	1 6 910	"
" 44,000 "	" "	340,853	"
" 39,600 "	" "	409,481	"
" 39,600 "	" "	480,852	"
" 35,200 "	" "	10,141,645	"

Permanent strain..22,000 lbs. Additional changing strain. .... 26.400 lbs.	48,400 lbs.	2,373,474	extensions broken.
Permanent strain. 26,400 lbs. Additional changing strain.....22,000 lbs.	48,400 lbs.	4,000,000	" not broken.

A comparison of these experiments with those of Mr. Fairbairn gives evidence:

1. That the number of experiments after which Mr. Fairbairn's girder did not break is too small to draw any conclusion therefrom as to the durability of his girder under lower strains.

2. That there is a limit of strain for which, practically speaking, the iron is indestructible, and which for the class of Phœnix iron stands at about 32,000 lbs. per square inch.

3. That neither the ultimate strength of iron nor the elastic limit stands in any proportion to the durability, which we must consider the only standard from which in future the value of a bridge will have to be judged. But

4. That Mr. Fairbairn's experiments give perfect evidence that *not even so much as 50 per cent. of the value of the material* under the arrangement of his girder is utilized. Where is the hoped for safety for four or five-fold the maximum load, when we learn that more than 400,000 deflections can be sustained by a good iron bar under a strain of 50,000 pounds, and when a strain of 30,000 pounds does not produce any change in the quality of a good iron bar after more than 132 millions of impacts, while Mr. Fairbairn's girder under a strain of 9.36 tons breaks after 5,175 repetitions?

Having now reviewed a sufficient number of experiments of all kinds, and having sufficiently proved that the rules of riveting require modification and judgment in their administration, it will not require much credulity to believe in the reports given by trustworthy parties, that a number of European riveted bridges, though yet of a very short life, have already required thorough overhauling. New covering plates, reinforcing plates, etc., are reported to have been drawn in, and it was found necessary to considerably strengthen them generally.

Fortunately European railroad engineers appreciate the necessity of careful and frequent examination of their bridges, and they are at the same time compelled to make inspections. Disasters have been prevented thereby and the evil features of the system have not become generally known.

We will now proceed to discuss the details of American trusses, and will endeavor to prove that these, if properly proportioned, offer greater safety than those of the European engineers.

For compression members we have the plain butt joint, which was early used in Europe for arch bridges, and was also applied to truss bridges previous to the introduction of the rivet. Again, for tensional members, eyebars and pin-joints are used, which were first introduced in America during the last century for suspension bridges, a long time before the use of wrought-iron trusses.

The contraposition of plain surfaces for members in compression apparently is the simplest solution of the question how the pressure from one part may be transferred to the other. All that is necessary to be done is to work the end surfaces accurately parallel and to take care to prevent lateral deviation, which certainly can be done very readily.

The continuous compression chord of riveted structures receives additional strains by flexure of the truss. The plain butt joint is accompanied with the same flexure, since these joints are held together by pressure. However, the camber can be made very useful, if arranged in such a manner that the chord is nearly straight under the full load of the bridge. Thus only a small camber will remain, by which a moment is created acting against flexure of the piece by its own weight.

Both methods of forming the upper chord, therefore, agree with the static conditions; but still the transmission of pressure by rivets is less reliable, and the additional flexure of the rivet bodies produces somewhat greater deflections. The plain butt joint, therefore, still has scientific advantages over the joint formed by cover plates and rivets, and should be preferred on account of economy. This joint permits the use of the best cross section for compression members, and by arranging lateral struts and diagonals at every joint the very strongest and stiffest system of chords is produced.

The most reliable tensile members of American bridges thus far are eye-bars, which are formed without a weld by upsetting under hydraulic pressure.

The danger of rupture of welded pieces was the reason eye-bars lost reputation in Europe. This danger, indeed, should not be underrated, and is established both by experiments and actual practice. For instance, railroad tires manufactured by the best methods of welding are reported in European books invariably to give way in the weld having been in use for some time. Therefore, welds of important bridge members always should be made so that a greater margin for safety will exist where the two parts are united. The danger of a rupture in the weld was the reason why Telford used upset bars for the Menai Suspension Bridge, and why the elder Brunel designed his long chain links, which diminished

this danger, but still were welded and in the average broke under 27,000 lbs. per square inch.

For the same reason links were forged from blooms, and Howard in England has invented his rolled eye-bars, which perhaps form the most preferable material, but can be obtained only in short lengths.

In the United States much attention has been paid to the production of weldless eye-bars.

Proper and powerful tools have been introduced in order to obtain *uniform* and *reliable* manufacture, which should be as free as possible from the accidental faults apt to be connected with human labor.

First the principle of wedge and screw were tried, but finally Mr. G. Sellers resorted to the application of the hydraulic press. His mode of manufacture is this: The end of the bar of proper shape of cross-section is brought to a welding heat in a reverberatory furnace, and then is upset in a closed form into the shape of a cylindrical lump thicker than the bar. After this process the bar, having been reheated in a second furnace, is brought under a second press, which flattens the lump and shapes the eye; and finally, under a third press, a hole is punched, which of course is smaller than the future pinhole.

Finally, both holes of a bar are bored at the same time under drill presses, which are carried by an iron frame.

This process has a number of good qualities.

1. The iron, heated in the smoky flame of the furnace, or in the neutral flame of a gas furnace, under proper care is free from the danger of being burnt, which more easily happens in the lower heat of a smith's fire, in which the iron is also in contact with the fuel.

Since the gang serving the apparatus has to work together, and is led by a foreman, and as the fire is regulated by a skilled heater, the danger of burning the iron is still further reduced.

2. The upsetting process, if bars of proper proportions are used, is free from irregularities.

3. The second heating of the lump takes but little time, and removes inequalities arising from the upsetting process. In this regard we need only call to mind the favorable effect produced on the iron of piles for rails and beams by returning them to the heating furnaces after the passage of the roughing rolls before drawing them out in the finishers. In this way the unequal extensions and deformations arising from the first rolls are equalized, and bars are produced of the same good quality as those made of artificially formed billets. Exactly the same favorable effect can justly be expected from the second heat given to the lump of the upset bars.

4. The second press, if properly arranged, not only acts as a powerful aid in welding the fibres together, but it also produces a considerable condensation of the iron.

5. The eyes thus formed are of fine exterior, of exactly equal dimensions, and, in consequence of the use of a proper boring tool, are of exact lengths between the hole centers. Inequalities of length arising from change of temperature are rendered impossible, under proper management.

Experiments in rupturing of these bars show a very high degree of *uniformity*, which should be a principal recommendation. The writer has made observations on the properties of this process during his presence at one of the works where they are manufactured, and he can state that he never saw a bar break with less than 45,000 pounds per square inch, but in one case he saw a bar torn in parts through the eye and in the body at the same time under a strain of about 50,000 pounds per square inch.

It is to be regretted that no experiments on repeated extensions have been made, in order to detect the limit of durability and whether and how much the limit of durability of the finished bar is below the limit of a plain bar, which should be expected for the iron in use at about 30,000 lbs. per square inch. The process described, however, requires a great outlay for the machinery, and will not pay unless a great supply of orders is guaranteed. Its application is also limited to certain proportions of bars, eyes and pins. Thus, the width of the bar should not be larger than four times its thickness; the width of the eye should not be larger than 2¼ times the width of the bar, and since 50 per cent. of additional metal is required across the pinhole the thickness of the pin is limited to the width of the bar.

Mr. Sellers, therefore, has lately experimented on uniting the processes of upsetting and welding by piling a piece of iron on top of the bar and upsetting this pile together. He hopes thereby to be able to extend the limits of use of his process.

However, since under these circumstances a partial return is made toward welded bars, the question arises whether it is not possible to produce perfect members by improving the process of welding.

Not being in possession of experiments which would give a proper standard of the value of eye-bars under use in a bridge for comparison, we can only use results of experiments carried to a rupture. The strength of good American rolled beams stands between 41,000 and 48,000 lbs.; and since there cannot exist any better beam than a rolled one of good proportion and manufacture, which, as we know, surpasses a plain riveted girder by at least 10 per cent., we conclude that good eye-bars surpass still more the strength of riveted girders. The strength of rolled beams stands to that of weldless bars as:

$$41{,}000+48{,}000 : 45{,}000+50{,}000=89 : 95=100 : 107.$$

The eye-bars, therefore, give connections 7+10 per cent. = 17 per cent. stronger than can be offered by the very best experimental riveted girder.

Since it is but the part of caution not to trust too implicitly the experiments on riveting, on account of the variability of the quality of labor, we put the ultimate strength of connections with eye-bars 20 per cent. higher than the best arrangement with rivets.

We know of no reliable method of testing the quality of riveted work, while the security against weakness of eye-bars on Sellers' plan rests in the mode of manufacture itself, which excludes chance almost perfectly, and this security moreover is increased by testing each bar to a strain near to the elastic limit.

The only case in which American engineers of experience use riveted girders is for cross-bearers and stringers of the floor system, when rolled girders are insufficient, or also for very short spans. Here only a shearing strain is exerted on the rivet, and it is not used to form tensile connections. If such girders are only strained to 9,000 lbs. instead of 10,000; if, further, in the calculation the height of the girder is put equal to the distance between the upper and lower row of rivets of the web; if this web itself is made about 30 per cent stronger than indicated by purely scientific consideration, and if it is sufficiently stiffened and made of one single piece, then it will be possible, assuming good work, to produce girders which are heavier than rolled beams but which about equal these in ultimate strength (when designed to stand strains of 10,000 pounds). But as soon as beams are rolled of 20 in. and 24 in. depth, for which at present preparations are going on in two works, the riveted cross-bearers and stringers will also soon disappear, at least will be proscribed by railroad engineers who appreciate quality.

The best American bridges are built with pin connections at each point. The accurately-turned pin fits into the accurately-bored holes with a play less than 1-32 of an inch. Its action depends solely on the strength derived from the well-established theory of flexure of plain bars, which has been fully confirmed after a great number of trustworthy experiments in all civilized countries.

The action of the pin does not depend on a combination of flexure with an unknown quantity of friction, nor does its working rely on suppositions which, like the complete filling of the rivet-holes, cannot be guaranteed; but with pins we know with certainty that they fit the drilled holes with an accuracy which we can examine. Here in all respects we have the best mode of mechanical labor; all holes are bored. If the same condition were prescribed for rivet-holes, this class of work could not be introduced at all into a new country, which, like the United States, comparatively is not rich in human labor. Each rivet is upset; each rivet is permanently strained beyond the elastic limit; the fibres of each rivet are distorted, and the weakness arising therefrom is not removed, as is the case with the double-headed eye-bars.

The pin is precisely as strong as the rolling mill furnishes the iron; there is no longitudinal tension, no distortion of fibres. It is impossible to calculate scientifically the strength of rivets, but we can calculate the strength of a pin with a degree of accuracy which is perfectly satisfactory.

It was only a consequence of imperfect tests on rivets and their improper application to pins which induced other engineers to arrange too small diameters. The eyes began to wear out, and in the Crumlin viaduct a return was made towards riveted work. Many books of late date even still recommend proportions for which the pins would be by far too small.

In this regard there are two conditions which require the attention of engineers: first the conditions of proper strains, and then the consideration of wear and tear. In fact, a thorough consideration of the first includes the second; but generally the actual strains are little known, and therefore it will be better to separate the two. The English engineers, when beginning to investigate the strength of pins, considered at first only the shearing force (single-acting and double-acting); then they repeated experiments made earlier by the German engineer Malberg, and they tested wide and thin eye-bars, such as are used in suspension bridges connected by double-shearing rivets, and found that in order to reduce the pressure sufficiently the pin should be ⅝ to ¾ of the width of the bar. On account of their test bars being too thin they overlooked the fact that the pin may have to stand important flexures. A simple examination of the question without any test under application of the most elementary principles of flexure could readily have convinced them that there is a limit from which the pressure in the pin-holes begins to be unimportant; and from which the flexure alone includes the other conditions.

The writer has carefully examined this point, and has found that the greater diameters which meanwhile have been introduced by American engineers are but too well justified. Some engineers calculate pins according to the rule that the shearing force considered as uniformly distributed over the cross section shall be 6,000 lbs. per square inch, when the general strain is 10,000 pounds, agreeing exactly with a theory requiring the section of the pin to be at least 1¾ times the section of the bar. This consideration by itself alone is not yet sufficient, and other engineers use diameters of pins from four-fifths to six-sixths of the width of the bars. Especially are large-sized chord-pins required, as they are subject to considerable flexure, and if too long or of too small diameter cause appreciably large changes in the distribution of strains over the bottom chord-bars. In regard to pin connections, our experience being still a short one, it is necessary to examine more carefully the distribution of the pressure over the bearing surface. In a perfectly fitting pin without play the pressure would be uniformly distributed over the cross section of the pin, and a 3-inch pin for a 4-inch bar would have to stand $4\text{-}3 \times 10{,}000$ lbs. $= 13{,}333$ lbs. per square inch. In reality, on account of the play, the pressure is much greater according to the amount of the play, and the writer has found by calculation that of pins three-fourths of the width of the bar a play of 1-32 of one inch produces a maximum pressure of over 25,000 lbs., the play of 1-100 of one inch producing a pressure of only 17,500 lbs.

When a single experiment is made up to the ultimate strength, a permanent set takes place, the hole is drawn out and becomes pear-shaped, the pin now fits accurately, and finally the pressure per square inch is greater in the same ratio as that between width of bar and diameter; in other words, when a 4-inch bar is strained to 54,000 lbs. per square inch, the 3-inch pin will produce a pressure of $4\text{-}3 \times 54{,}000 = 72{,}000$ lbs.

The English engineers, at that time not being familiar with the fact that iron when protected from flexure is capable of standing an amount of pressure greater than that of tension, resorted to the explanation that the pressure must be considered as being distributed over the semi-circle of the pin section. But this view is utterly opposed to the first principle of mechanics, namely, that a force can only be resisted by another acting in the same straight line but opposite to the direction of the first.

Henrici, in his book on skeleton structures, arrives at the rule to make the diameter equal to the width of the bar.

The English engineers prefer the rivet connections to pins, especially on the ground that the latter would cause an early wearing out of the bridge.

Indeed, they had good reason for this objection under the application of their rule. This objection is less justified now, but though the Americans have increased the strength and durability of their connections, it is not proved that they are sufficiently strong yet. If the eyes and pins are loaded beyond the strains allowed for the rest of the bars, either we can as well allow higher strains throughout, or we waste metal in the same manner as occurs with riveted structures.

That experiments on eye-bars to the ultimate strength cannot lead to proper rules, the various arguments are believed to prove sufficiently. Of course it must be expected that a number of builders will object to improvements in this direction. They will say that such and such a rule is good "for all practical purposes," which purposes in reality are these: to design structures with the view of satisfying the party ordering, and more especially with the view of being the lowest bidder. Under the great factor of safety such a bridge is *sure* to stand, and the object in view is attained. The secret which underlies their arguments is really this: that they will adopt the smallest practicable width of bar for the sake of the lower cost of iron; that this small size of bar also, according to the rule, requires smaller pins, and that the price per pound of pins is about twice as high as the average price of the ironwork.

At the same time, these builders are apt to use comparatively short panels, in order to get small sections of chord pieces, and therefore they use numerous pins, and, of course, will reduce their size to a minimum. Leading American firms are not influenced by such "practical" considerations, and honestly wish to improve their designs whenever they see a chance. In order to remove the objections of the English engineers, it will be well to increase the diameter of pins to at least nearly the width of the bar, and to reduce the play in the pin-hole to less than 1-50th of an inch. Such a course will require the very finest tools and the very best workmanship and accuracy, in order to make the connections in the field, but it will be preferred by firms who wish to maintain a reputation.

What we have said in regard to pins applies also to the eyes. These should not be designed solely with the view of making their ultimate strength equal to the strength of the bar, but with the view of reducing the tensile strain in any of its points to the tensile strain for which the rest of the bar has been proportioned.

It may be said to be impossible to determine the proportions of the eye solely by calculation, and that the only proper way to find a trustworthy rule will be to make a set of experiments by repeated extensions, in the manner in which Mr. Woehler has done this for plain bars. Meanwhile engineers are compelled to use their judgment, to put metal enough into the eye and to bring it into such a shape as will be most in accord with the principles of strength, and will invariably cause rupture in the body of the bar.

Notwithstanding the improvements for which there is still room with reference to pin connections, this much is believed to be proved, that:

1. In consideration of the ultimate strength which in England and in the United States at present still forms the standard for comparison, the pin-joint shows advantages of 20 per cent. over the best riveted girder.

2. That there remains no objection whatever which can justly be raised against this detail, provided that the diameter of the pin is made large enough; further, that the workmanship is of the proper kind, that the play in the hole is reduced to the attainable practicable minimum, and lastly, that the size and the shape of the eye are so designed as to reduce the strain in any point to the same maximum that has been specified for the whole bridge.

In order to complete the comparison of rivets and turned pins, a few words are still necessary. Sometimes it is mentioned as an advantage of rivets that their heads secure permanent connection, while screw nuts frequently get loose. In this regard it can be rejoined that rivet-heads frequently fly off, while no complaints have been heard from loss of pin-nuts. However, we know that the economy of the system with pin joints is great enough to admit the use of safety nuts or their substitutes, if desired. The pin connection is not only scientifically well founded, but also capable of the most rigid examination, and especially it possesses the advantage of reduced risk under rapid and economical erection, whereby the employment of skilled labor can be dispensed with. By the use of this connection it is also possible to do more business and to fill orders in the least possible time.

Only a few remarks are still necessary to complete the review of the principal details of American bridges.

It has been mentioned that Mr. Reeves has made experiments on his columns, and that he has proved that the figures for their ultimate strength are by far higher than those given by Hodgkinson or Gordon. It was long known that Hodgkinson's experiments could not possibly be reliable either in regard to the models used, or with reference to the results derived therefrom.

Thus, for instance, columns with flat ends 53¼ diameters long became useless under a pressure of 30,274 lbs. per

square inch (Gordon's formula only gives 18,430 lbs). Another column, with rounded end, broke under 16,387 lbs. per square inch (Gordon calculates 7,457). A column 35.9 diameters long broke under 37,561 lbs. per square inch, and another of 35.88 diameters long under 38,235 lbs. (Gordon gives only 25,191 lbs.).

In bridges these members are connected by short cast-iron joint-boxes, provided with tenons entering their interior. The castings are faced accurately and are reinforced by ribs, and by hubs receiving the pins.

Castings for the connection of wrought-iron compression members were first recommended in France, and probably form the very best detail for such connections. For a short cast-iron or steel box, reinforced by ribs, tenons and hubs, of sufficient, nearly uniform thickness of metal, open for inspection inside and outside, cannot be surpassed by a wrought-iron connection, and possesses the most valuable advantage of giving the opportunity of transferring the pressures as *uniformly as possible over the total sections* from one member to another. This can be done very easily by putting sufficient metal in the proper shape, whereby the strains are transferred uniformly from molecule to molecule, and are not accumulated in a few points, as is the case with riveted connections.

Especially it should not be overlooked that with this detail the strain is transferred accurately to the longitudinal axis of gravity of each member, and that it is favorably distinguished from the arrangement, almost universally applied in European bridges, of forming the top chord in shape of a built ⌐ iron, and of riveting the posts and ties to their vertical plates, in which the pressures accumulate and must be transferred by flexure to the rest of the sections.

Finally, we turn to the comparison of the manufacture and of the erection of bridges built on the two different systems.

In Europe it seems to be usual that government and other civil engineers make the designs, on which bids are tendered by the bridge works. This mode apparently is less suitable than the mode generally followed in America, since it can be justly assumed that according to the European custom the designer possesses only a part of the experience of the bridge business proper, and that he has occupied himself more especially only with its theory.

Therefore it will also happen that in the majority of cases the design will be more costly, heavier, and yet less mechanical, because the works are *not prepared* for the execution of the ideas of the designer.

In the United States it is usual to specify only the principal conditions, as span, rolling load, maximum strain and plan of abutments, but to leave the design to the bridge engineer, who is enabled to make his proposition often on the same day, and his bid will be the more reliable as he knows exactly the weights and prices of the details for whose manufacture the firm is prepared. Patterns are at hand, few templets are necessary, if any at all, forms for the eye-bars likewise are ready, every part is plain and can easily be prepared. Every member is complete in itself, and it is not necessary to fit one part to the adjoining ones, as is the case with riveted work.

Costly preparations, such as are indispensable for building reliable riveted structures of any magnitude, are not necessary for the execution of American bridges. In order to produce good riveted work a perfect plant must be prepared, such as actually is used by European firms of note. Each plate must be heated and straightened under rollers before being laid out; the best class of punching machines must be used, with self-acting arrangements, to secure mathematically equal rivet distances; or else the plates must be put together and holes must be bored at the same time through the plates to be connected by rivets. In case of punching with ordinary machines, each hole must be reamed but not drift-pinned, and riveting tools of proper weight, 16 to 18 lbs. apiece, must be applied in order to secure a sufficiently powerful blow when forming the heads, in case the riveting machine cannot be used.

In the United States there is not one establishment which at present is prepared to build large riveted structures of reliability equal with the work furnished by first-class European firms.

On the other hand, there are several large establishments in the United States which are prepared to furnish American work of the highest degree of perfection. They are enabled to turn out good material in a very short time, apparently without any great exertion.

Thus, for instance, the High Bridge over the Appomattoc River in Virginia, designed by Mr. C. H. Latrobe, which consists of 21 spans of 110 feet each, was completely finished within four months. During this time the iron was manufactured, worked in the shops, shipped, the old wooden bridge was taken down, iron piers were placed, and the 21 spans were put up. There are many other examples of equally rapid construction and erection.

The American bridges have some other advantages over the European mode of construction.

Their parts are finished in themselves, are of proper lengths to be carried by railroad cars, and can easily be handled. The erection of large riveted structures in a country like the United States would hardly be practicable. The erection of American bridges, on the contrary, can be accomplished by a foreman, who has been occupied during a great part of his life exclusively with work of this kind, and who needs only to call together a number of ordinary laborers, by a newspaper advertisement. The erection of riveted bridges, however, needs gangs of skilled men, many precautions, is more costly, and increases the risks from accidents.

Combining all that has been said, the assertion is believed to be justified that bridges with pin connections, as they are built by leading American engineers, are *not in the least less perfect* than riveted structures as used in Europe; but that they offer great advantages over these, since it has been proved, not only that they are arranged more *scientifically* as far as concerns general design as well as the connections, but that they must be indeed about 20 per cent. stronger, when the ultimate strength is drawn into account; and that in such structures the *proper class of iron is put in its proper place* and in the *best shape*. It has been found that a *reduction of weight* of material of from 25 to more per cent. is possible when compared with European riveted structures designed for the same load and strains.

Every part of one of the American bridges can be *examined* thoroughly after completion in the shops, and the *mode of manufacture* in most cases includes also the *guarantee* of its quality. The manufacture itself can be accomplished *very rapidly*, and the *erection* especially can be done quickly, without skilled labor, and with a reduction of danger from accidents.

Finally, such bridges offer considerably less surface to the action of *wind, moisture* and *the heat of the sun* than is the case with bridges built on the European plan of angles and plates.

ANNUAL REPORTS.

Cumberland Valley.

This company owns a line from Harrisburg, Pa., southwest to Williamsport, Md., 82 miles. It operates under lease the Martinsburg & Potomac road, from Williamsport to Martinsburg, W. Va., 12 miles; the Southern Pennsylvania road, 23 miles, and the Dillsburg & Mechanicsburg road, 8 miles. The Martinsburg & Potomac road and 8 miles of the main line, from Hagerstown to Williamsport, were not opened for business until just at the close of the year. The Dillsburg & Mechanicsburg road was opened July 14, 1873.

The operations for the year ending September 30 were as follows:

Earnings:	1873.	1872.
Passengers	$218,352 43	$189,632 99
Freight	411,153 34	374 593 18
Mail, express and miscellaneous	21,559 95	16,838 40
Total earnings	$651,065 72	$581.061 57
Expenses:		
Conducting transportation	$85 794 43	
Motive power	103,532 34	
Maintenance of way	95,255 11	
Maintenance of cars	10,374 05	
General expenses	12,784 65	
Total expenses	$307,840 58	$293 074 61
Net earnings	$343,225 14	$287.986 96

The earnings are divided as follows between the different lines:

	Earnings.	Expenses.	Net earn'gs.	Per ct. of exps.	Earn. pr m.
Main line	$614.184 99	$282,542 44	$331,642 55	46	$8,300
Southern Penn..	31,944 58	23,084 22	8 860 36	72.26	1,389
Dillsburg & Mech. (2¼ months)...	4,936 15	2 213 92	2,722 23	44 85	617

The whole number of passengers carried on the main line was 321,815; branches, 33,097; total, 354,912. The train mileage for the year was: passenger, 150,530 miles; freight, 175,090 miles; construction and other trains, 18,330 miles; total, 343,950 miles. The tonnage of iron ore has increased from 52,948 tons in 1872 to 100,712 tons in 1873, an increase of 90 per cent.

During the year nine spans of the Susquehanna Bridge have been renewed and one pier rebuilt. There have been put in the track 200 tons steel rails, 477 tons rerolled iron rails and 16,030 new ties. New buildings are needed at Chambersburg and Mechanicsburg, and additional car and paint shops. During the year $141,331.40 was advanced to the Martinsburg & Potomac Company, for which bonds were received. The Southern Pennsylvania road was sold under foreclosure in December, 1872, subject to the lease, and the company reorganized.

During the year the stockholders have subscribed for $199,800 (3,996 shares) of new stock at par. The capital account at the close of the year stood as follows.

	1873.	1872.
First preferred stock	$74 ,900.00	$241,900
Second preferred stock	243,000.00	243.000
Common stock	1,290,012.50	1.009,350
Total stock	$1,774,912.50	$1,494,250
First mortgage, 8 per cent. bonds	161,000.00	161,000
Second mortgage, 8 per cent. bonds	109 500.00	109.500
Common mortgage, 6 per cent. bonds	81,800.00	81,800
Total funded debt	$352,300.00	$352,300

The stock is $21,645 and the funded debt $4,296 per mile of road owned. The annual interest charge is $26,548, or $324 per mile. During the year covered by the report payments on interest account were $26,378.90, and for dividends $119,288.76.

North Pennsylvania.

This company's road extends from Philadelphia northward to Bethlehem, 56 miles, with branches to Doylestown, 10 miles, and to Shimerville, 2 miles. It works under lease the Northeast Pennsylvania road, from Abington to Hatboro, 6 miles.

The operations for the year ending October 31 were as follows:

Earnings:	1873.	1872.
Passengers	$493.146 30	$452,187 26
Freight	611,835 71	600.678 89
Coal	351,998 03	268.618 25
Mails	6 165 00	4.800 00
Miscellaneous	14,395 04	10,653 96
Total earnings	$1 477,540 08	$1,336,938 36
Expenses:		
Maintenance of way	$263,815 96	$176.2 9 17
Motive power	265,451 23	206.693 40
Maintenance of cars	80,749 76	77 840 74
Conducting transportation	282,802 36	240 111 37
General expenses	38,754 59	31,954 57
Total expenses	$931,573 90	$732,829 .7
Net earnings	$545 966 18	$604.109 09
Interest, taxes, etc	350.321 54	
Balance to profit and loss	$195,644 64	
Total amount to credit of profit and loss at close of year	462,194 93	

There is an increase of $140,601.72, or 20½ per cent., in earnings; an increase of $198,744.63, or 27¼ per cent., in expenses; and a decrease of $58,142.91, or 9⅝ per cent. in net earnings. The operating expenses were 63 per cent. in 1873 and 54¾ per cent. in 1872. The gross earnings were $20,240 and the net earnings $7,479 per mile, against $19,661 and $8,884 the preceding year.

There has been advanced:

To the Stony Creek Railroad Company	$287,873 75
To the Northeast Pennsylvania Railroad Company	45,768 50
Total cash advances	$333,642 25

The Northeast Pennsylvania Railroad was opened for business on December 18, 1872, since which time trains have been run through between Philadelphia and Hatboro. The gross receipts up to October 31, 1873, were $13,540.47, and the expenses were $15,089.46, leaving a deficit of $1,548.99, to which is to be added $12,004.93 for interest and taxes, making a total deficit of $13,553.92. The work on the extension of the road to the Bristol road near Hartsville is progressing, and it is contemplated to lay the rails and open the road early in the coming spring.

The Stony Creek Railroad from Lansdale on this road to Norristown has been completed, and trains are running through from Norristown to Doylestown.

The capital stock has been increased during the year by $123,000 and is now $3,596,000, or $52,882 per mile owned. A scrip dividend of 5 per cent. has been declared, convertible into stock February 1, 1874.

The permanent accounts have been increased $163,867.22 for construction, equipment, real estate, depots, shops and stations.

The bonded debt has been increased $407,000, and is now $4,449,500, or $65,434 per mile. The annual interest charge is $300,375, or $4,417 per mile.

The Belgian Railroads.

Although the report, widely published and credited, that the working expenses of the Belgian State Railroads for the year 1874 were 78 or 80 per cent., has never been contradicted, a recent estimate presented to the Parliament for a large deficiency appropriation to the Department of Public Works on account of railroads indicates that these working expenses were only about 67¼ per cent., against 59.95 per cent. in 1872, and the increase is nearly all accounted for by the higher prices of coal and iron. The working expenses plus the rentals paid for the use of railroads not owned by the State would, on this basis, amount to about 81 per cent., so that the portion of the gross earnings which forms the income on the State's investment is 19 per cent.

Commenting on this subject, M. Georges De Laneleye, an eminent Belgian economist, writes as follows in the *Moniteur des Interets Materiels:*

The organization of the State Railroads includes three kinds of results, summarized by the answers to the following questions:

1. What is the relation of the expenses to the gross receipts of the system?
2. What part of the gross receipts goes into the Treasury, and what is the revenue of the sums employed by the railroad?
3. What part of this same sum constitutes a reimbursement of the advances made by the Treasury to the administration of the railroads?

We are familiar with the answer to the first question. The following relation of the expenses to the receipts during the last five years:

1869	55.53 p. c.	1872	59.95 p. c.
1870	55.29 "	1873 (approximate)	67.75 "
1871	52.03 "		

It is seen that there is a very rapid gradation, which can be explained by diverse circumstances: increase of the system worked in 1871, insufficiency of rolling stock in 1872, rise in fuel in 1873. All these causes have their value, but it is none the less true that we have reached in Belgium, with respect to the working of railroads, a striking degree of inferiority, if these results are compared with those of the neighboring countries.

In order to find the sum really obtained by the Treasury, to the working expenses must be added the amount coming to the lessor companies; it was about 10,225,000 francs in 1872; it will certainly be more in 1873, say, for example, by 11,000,000 francs.

Then from the gross receipts	76,800,000
Must be subtracted	62,249,000
And there remains	14,551 000

In 1872 the surplus was about 17,436,000 francs, and in 1871 about 22,929,000. There is, then, a descending progression in the disposable revenue.

But meanwhile the capital invested has increased, and, for 1873, it is certain that at least 16,000,000 of the 57,000,000 of disposable appropriations will have been expended, or 16,000,000 to be added to the 334,313,000 francs forming the capital invested.

If so, the excess of the receipts over the expenses represents 4.15 per cent. of the capital employed. The following is the statement for the five years past:

1869	5.893 p. c.	1872	5.215 p. c.
1870	6.043 "	1873	4.187 "
1871	7.357 "		

Even in case that only this small part of the available appropriation has been used, the decrease is noticeable, and this source of income for the Treasury is seriously compromised.

Finally, the account which enables us to answer the third question is given below. Beginning again with a supposed gross receipt of 76,800,000 francs from the business of 1873, this sum is employed in the following manner, (we follow the order indicated by the State reports):

1. Working expenses	51,249,000
2. Cost of remunerating capital invested in lines leased, purchased or worked	10,897,000
3. Annual expense for the use of the capital invested by the Government	11,000,000
4. Balance turned into the Treasury, available as reimbursement of a part of its advances	3,654,000
Total, equalling gross receipts	76,800,000

In 1872 the Treasurer's reimbursement was 6,375,000 francs, or almost double the sum which it can apply for 1873, if our calculations are correct.

From the preceding figures we can then derive the triple conclusion which we have exposed heretofore:

1. The coefficient of working tends to rise in deplorable proportions.
2. The equipment of the railroads increases every year by sums newly expended, while we do not see the complaints of the customers of the State Railroad cease.
3. The revenue of the sums invested in the railroads is reduced to the point of becoming equal if not inferior to the interest which Belgium pays when it borrows, notwithstanding its great credit.

These considerations are far from being reassuring.

The Atlantic Car Company.

This company has voted to appoint a committee to sell it property, pay its debts, and finally wind up its affairs. A statement shows that the personal property on hand is valued at $39,918.17 and the cost of the shops (at Salem, Mass.) and machinery has been $93,025.74. The debts amount to $56,619.67. About $50,000 of the capital has been sunk during the operations. The property is to be sold under the supervision of a committee of the creditors, who have issued a circular requesting all creditors not to embarrass the settlement by proceedings in bankruptcy or otherwise.

Joliet Iron & Steel Company.

The Joliet creditors have held a meeting and resolved to accept the company's proposition, which is regarded as being a very fair one. Like action was taken by the employés at another meeting.

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Editorial Announcements.

Addresses.—*Business letters should be addressed and drafts made payable to* THE RAILROAD GAZETTE. *Communications for the attention of the Editors should be addressed* EDITOR RAILROAD GAZETTE.

Contributions.—*Subscribers and others will materially assist us in making our news accurate and complete if they will send us early information of events which take place under their observation, such as changes in railroad officers, organizations and changes of companies, the letting, progress and completion of contracts for new works or important improvements of old ones, experiments in the construction of roads and machinery and in their management, particulars as to the business of railroads, and suggestions as to its improvement. Discussions of subjects pertaining to* ALL DEPARTMENTS *of railroad business by men practically acquainted with them are especially desired. Officers will oblige us by forwarding early copies of notices of meetings, elections, appointments, and especially annual reports, some notice of all of which will be published.*

Advertisements.—*We wish it distinctly understood that we will entertain no proposition to publish anything in this journal for pay,* EXCEPT IN THE ADVERTISING COLUMNS. *We give in our editorial columns* OUR OWN *opinions, and those only, and in our news columns present only such matter as we consider interesting and important to our readers. Those who wish to recommend their inventions, machinery, supplies, financial schemes, etc., to our readers can do so fully in our advertising columns, but it is useless to ask us to recommend them editorially, either for money or in consideration of advertising patronage.*

ENGLISH VERSUS AMERICAN BRIDGES.

We have now published the views of able advocates of each system of iron-bridge construction, written independently of each other, and each one presenting his own views in the best light.

We shall endeavor to sum up the relative merits of the two systems, as they appear to us; but before doing so, it becomes necessary to point out and correct some erroneous statements which Mr Matheson has been led into in his effort to make out the best possible case for the system he advocates.

He very properly confines the comparison to "structures designed by our leading engineers;" and warns us "not to accept too readily as English types, bridges of second-rate men." He then goes on to make the positive assertion: "Our railroad bridges never give way." He then says: "In your journal of a few weeks ago, where you give a summary of the railroad accidents for the year 1873, I notice 19 cases of bridges giving way. I presume some of those were iron bridges. *So long as this is the case,* no asserted superiority of American systems will induce us to adopt them here in their entirety."

But what if this assumption were unfounded? The truth is that none of these bridges were iron bridges.

They were all of them worn-out or temporary structures of wood, which the railroad companies are now, we are happy to say, generally replacing with substantial iron bridges as fast as they can. There is as yet *no* instance on record of an iron bridge designed by any of our leading engineers or engineering firms which has ever given way.* Can Mr. Matheson say as much for English bridges?

*We recall the following failures of bridges built by reputable firms:

1. A bridge at Zanesville, Ohio, in 1868. The floor-beams were of wood and decayed, and it cannot properly be classed with iron structures.

2. A bridge on the Illinois Central in 1873. This bridge did not give way under a load but was knocked down by a train off the track running into an end post

3. A bridge on the Junction Railroad, near Philadelphia, in '73. A precis ly similar case to No. 2.

4. Another similar accident.

5. A bridge on the Louisville, Cincinnati & Lexington Railroad, in 1872. It was a *combination* bridge—wood and iron. The wood had rotted away and the whole structure collapsed.

6. A bridge on the New Jersey Midland in 1872. This bridge was not proportioned for the load it had to bear—that is, it was built for a light load and was subjected to a heavy one.

Mr. Matheson, in speaking of the comparative lightness of American bridges, considers that lightness in short spans, of, say, under 120 feet, is not desirable; and we would say that we here entirely agree with him, and for the reasons that he has well stated; and we think it will be found that our best practice provides for heavier rolling loads on short spans than is customary in England.

He then goes on to give several reasons why American bridges are lighter than English ones, as follows: "The employment of cast iron in parts under compression; the great depth of the girders in proportion to their length; the facility which the use of pin-joints allows of obtaining from the various members the effective use of their entire area; the omission in many American bridges of parapets and platforms, and, finally, the greater margin of safety which it is usual to give in England."

We may briefly dismiss the cast-iron argument by saying that no one of any repute uses cast-iron chords and posts here, and that he must "not accept too readily as" American "types the bridges of second-class men."

Like all English engineers, Mr. Matheson objects to the depth of our trusses, which, to his eye, seem all out of proper proportion. "In long spans," he tells us, "the depth of the girder is limited by the expense of stiffening laterally." But that is just where our economy of design comes in. As Mr. Evans has well expressed it, the superior strength of the American forms of compressive members enables the material to be better concentrated along the lines of strain, the panels are longer and the connections less frequent, and the trusses can be made higher without materially increasing the weight of their web or bracing system, and thereby lightening the weight of the chord system.

Mr. Matheson then goes on to give his reasons why he disapproves of pin joints; and here we must say that he argues in a manner not quite ingenuous, and not such as we should expect from one of his nation and reputation. After claiming as great accuracy of workmanship for his bridges as we can pretend to, he says it has been found in practice "that after a few years of traffic the bridge will be heard to rattle as a train passes over it, which shows that the fastenings are becoming loose." He then cites the oft-quoted case of the Crumlin viaduct, whose pin joints got loose and were removed, and riveted gussets substituted.

American engineers would reply that the fault of the Crumlin, and all other "rattling" bridges, was either owing to original bad workmanship, or else to bad proportioning of the areas of the pins and eyes, which allowed them to cut into each other, and probably to both of these causes. No pin-jointed bridges in this country, unless, indeed, badly designed, are ever liable to this objection.

Mr. Matheson has still another reason which, if true, supersedes the discussion of the rest. He says that English bridges have a greater margin of safety than American bridges.

So far is this from being true that we shall show that exactly the contrary is the case.

Stoney (vol. II., p. 383) says the British Board of Trade rule for railway bridges is as follows: "In a wrought-iron bridge the greatest load which can be brought upon it, added to the weight of superstructure, should not produce a greater strain on any part of the material than five tons per square inch. This rule is generally confined to parts in tension, while the usual limit of strain in the compression flanges is four tons per inch; and as the tearing and crushing strength of ordinary plate iron are respectively 20 and 16 tons per square inch, the foregoing rules are equivalent to stating that *one-fourth* of the breaking strain is the maximum safe working strain for wrought-iron girders subject to vibration; and this is now the recognized English practice."

The recognized American practice is to add to the dead weight of the bridge the greatest load which can be brought upon it, and that the combined load shall not produce a greater strain on any part of the material in tension than 10,000 lbs. per square inch, which is reduced in compression according to the ratio of diameter to length of the struts. The shearing strain upon pins is not allowed to exceed 7,500 lbs. per square inch. As the tensile strength specified for the iron used in American bridges is 60,000 lbs. per square inch,† this is equivalent to stating that *one-sixth* of the breaking strain is the maximum safe working strain.

So much for Mr. Matheson's greater English margin of safety. Having corrected these misstatements, we will now endeavor to sum up what seems to us to be the comparative merits and defects of the two systems.

An iron railroad bridge consists of two quite distinct parts: the floor system, and the girders or trusses which support that floor. The strength of the floor system of any bridge, and hence the quantity of iron in it per lineal foot, is quite independent of the length of span, and should be strong enough, in all spans, not only to bear the weight of the heaviest engines concentrated upon a short wheel-base, but also of shocks and blows to which it may be subjected in case of accidents.

†This is the tensile strength usually *specified* for the iron of American bridges; but we would not assert that the iron used is equal to the specifications; and in Mr. Bender's paper (page 139 of the last number of the RAILROAD GAZETTE) it is stated that this strength is rarely reached except in iron of small sections, and that 50,000 pounds is all that can be counted on for large sections. But with this ultimate strength the factor of safety is still five.

The trusses which support this floor vary in amount of material with their length, and must be strong enough to support the heaviest loads to which they may ever be subjected, and should also have a strength of coherence sufficient to resist an ordinary shock caused by accidents.

When we compare the floor system of American and English bridges, the first thing that strikes us is, that the American engineer seems to assume that derailment will never take place on a bridge, while the English engineer more prudently endeavors always to provide a floor across which trains can get without falling through, even when off the rails. In this point we cheerfully admit the superiority of English practice, and recommend American engineers to follow their example, not perhaps exactly in the same manner, but to aim to attain the same results.

When we come to examine the trusses which support the floor, we should say that it is not desirable to attempt to give excessive depth of truss to spans of 120 feet and under for the sake of saving iron. But in the case of these bridges where the track passes at the level of the lower chord, it is very desirable to carry up the height of the truss so as to allow the use of over-head bracing. Here is where the English system is weak. They seem to be so wedded to shallow girders that they resort to all sorts of expedients rather than increase their depth, such as to carry across overhead a species of arched bracing of the weakest possible form. Americans meet the difficulty squarely, by carrying up their trusses and bracing them securely overhead, at such a height as will allow room for the trains to pass through.

English engineers have been accustomed to design bridges for sites where the embankments are heavy, the grade line high above the stream, and the spans comparatively short; hence allowing of the use of deck bridges. There is no trouble in bracing these laterally.

American engineers have had to deal with the reverse of these conditions. The spans are long and the flood level rises high, so that they have been obliged to use more "through" bridges where the trusses are above the level of the rails. Experience has taught them that a truss, girder or beam of any kind is a very weak support unless prevented from yielding laterally; and hence they have learned the value of horizontal bracing, which English engineers do not seem to appreciate, but attempt to give lateral stiffness by enormously broad flanges attached to a single girder, instead of connecting the two girders together at once.

In very long spans of 300 feet and over, American engineers make their trusses so high that they are enabled to get in two sets of horizontal bracing, one above the other. Height of truss is thus a positive advantage and not a defect in long spans, as by it the lateral stiffness of the bridge is greatly increased.

When we come to examine the details of construction of the trusses, we shall find that American practice tends towards few parts, and these of large size—in other words, to concentration.

The English practice is the reverse, and tends to diffusion of strains, and many parts and connections. The advocates of this system claim for it greater power of resistance against sudden shocks and blows; but this position is clearly untenable. The more massive our parts are, and the fewer of them there are, the less liable will they be to be injured by blows.

The instance quoted by Mr. Evans, where the bridge at Albany received without injury a very severe shock, corroborates the truth of our position. As long as the parts are well connected together, there is no danger.

As to the comparative value of pins and rivets, Americans use rivets just as much as the English do in connecting together the separate pieces of iron which form the struts, floor-beams and other parts of their bridges. They prefer to use pins and eyes for connecting together the main parts of their bridges for the reasons clearly set forth by Mr. Evans in his letter, and until some better arguments than those of Mr. Matheson can be brought against their use, will continue to use them.

Mr. Matheson has asked one very pertinent question, which every engineer should ask himself when deciding upon a plan submitted to him. He says: "Will that bridge withstand a sudden shock and exceptionally heavy or unequal loads, and is it as likely, after 20 years of railroad life and use, to exhibit such a good condition and fitness for the future?"

Let us see how the American system stands this test.

Deterioration, as Mr. Evans has well pointed out, is of two kinds: that from use and that from rust. Experience has shown that bridges, if improperly proportioned, begin to wear out first at the joints or connections. The Crumlin Viaduct, quoted by Mr. Matheson, is a case in point. Mr. Evans then goes on to show why the American system is less likely to have its bridges deteriorate from this cause than the English riveted lattices.

Less likely, we say, for it must be remembered that riveted bridges, if equally well proportioned and as carefully and exactly made, will give as good results as the others. It is for the engineer to look carefully to this point, and remember that the cost of attaining perfect accuracy of fit in hand-made work is much greater than in machine-made work, and hence less likely to be attained. In reality it is very seldom attained. The pin-connected bridges come together with perfect accuracy and ease, like the parts of a steam engine or any other piece of machinery made to standard gauges. The actual camber and deflection coincides with the calculated camber and deflection. After the load has passed, the bridge returns to the camber given it before.

A bridge in which the main parts are connected together by riveting never does this. After the wedges are struck it compresses in the loose upper joints, stretches in the loose lower ones, and after heavy weights have been piled upon it, it "comes to its bearings." Sometimes, as in the case of the lower span of the Victoria bridge, quoted by Mr. Evans, it actually settles below a horizontal line.

As to deterioration from rust, we may lay down the proposition broadly and without any exception, that there is but one way to prevent a bridge or any other construction of iron from decay and that is by frequent paintings of the exposed surfaces.

It must be admitted that a riveted girder is the simplest and easiest form, next to a rolled beam, to paint; but no one makes riveted girders of over 50 or 60 feet span. As for the riveted lattice, which comes next, Mr. Evans states that the American pin-connected truss exposes nearly 50 per cent. less surface to the weather, owing to its concentration; a strong point in its favor. There may be a difficulty in painting the pin-connected bridge as imagined by Mr. Matheson, but there is no difficulty in painting it as actually constructed by American engineers.

Finally, we must remember that the economic limit of span is much more quickly reached in the English than in the American system. In other words, the latter is the only system by which great spans can be made at all, with any respect to cost.

The last point of comparison is quickness and facility of erection. And here there is no doubt of the superiority of the American or pin-connected system. Mr. Matheson frankly admits this, and says, "that where bridges are designed and made in England for places in India, Australia, South America and other countries where skilled labor for erection is unobtainable, or where staging for riveting would be very expensive, pin-joints are almost universally preferred."

After this broad statement is there not a slight inconsistency in Mr. Matheson's unqualified condemnation of such constructions? We hope he does not think that "anything is good enough for the Colonies," nor anticipate that time, to which he refers at the close of his letter, when English engineers "may possibly have become affected by the spirit of the age and make bridges with the one consideration that they will sell." That spirit is altogether an evil one, and reputable American engineers and bridge-builders will, we are sure, be found equally ready with the most conscientious of English ones to exorcise it.

"Postal Cars or No Postal Cars."

This is the title of a pamphlet recently published, under the supervision, we presume, of Mr. Isaac Hinckley, President of the Philadelphia, Wilmington & Baltimore Company, who has for so many years had the management of the movement to secure for the railroad companies compensation for transporting mails in postal cars approaching the cost of doing that work. We do not know that it contains much that is new in the way of argument, there was hardly room for that; for the proof has been abundant, clear, and clearly put, and there has been scarcely a shadow of an argument or attempt at argument on the other side. The attitude of the Government really has been very much like that of the highway robber, who may listen to your expostulations and admit that he has no right to your property, but takes it nevertheless. The importance of the pamphlet consists chiefly in its declaration, after a summary of the facts in the case, that the railroads positively will not carry the mails after the present session of Congress unless that body meanwhile makes a provision for something like adequate compensation for the service. The arguments are repeated and the evidence resumed. It is shown again that the rates received are not more than one-quarter or one-fourth of those paid by the public and very much less than the cost of the service to the companies, and that the rate suggested by the companies is not more than two-thirds of the charge for similar service to other customers; while on the average working expenses of railroads are just about two-thirds of their receipts. A draft of the bill providing this rate of compensation (1.3 cents per foot of length of postal car per mile) is given; and also of another bill, of itself evidence of fairness and a desire for a settlement on a just basis, which proposes to submit the question of compensation, when the Post Office Department and the railroad companies cannot agree, to a reference, as has been the practice in Great Britain since 1838. By this latter bill, if a railroad company shall notify the Postmaster General that the compensation received by it is inadequate, or the Postmaster General shall notify a railroad company that the compensation paid it is excessive, the matter shall be referred to three persons, one chosen by the Postmaster General, one by the railroad company and the third by these two, whose award shall determine the rate of compensation from the date of the notification on which the claim was submitted. The other law limits the authorization of the payment of 1.3 cents per foot of car per mile to those cases in which this compensation would not exceed *two-thirds of the rate* paid the same company for running an equal bulk of express cars.

Having stated the case, collected the evidence, and put the case so clearly that every child can understand it, Mr. Hinckley says, speaking for his own road:

"We now purpose leaving the question of postal cars or no postal cars upon this company's road to be decided upon at Washington, having done all that we can to throw light upon it. And whatever be the result, we feel that we have done our duty in the premises, and that an intelligent public will give us the credit of having for ten years past sustained annually large losses in consequence of our unwillingness to withhold any of the facilities asked for by your department so long as we had hope of redress."

The "intelligent public," we fear, takes little interest in the question, having, indeed, such an officer as a Postmaster-General and such a body as Congress for the very purpose of taking care of such questions for it. And when the withdrawal of the postal cars comes, if come it must, doubtless a very large portion if not most of this intelligent public will be inclined to believe that the act is an arbitrary exercise of power by extortionate railroad corporations. But the great inconveniences resulting from the cessation of postal-car service would at least attract general attention to the subject, and in this case attention to the subject can have only one result—the acknowledgment that the railroads have a solid basis for their complaints and have shown the most extraordinary patience in seeking for a remedy.

RAILROAD EARNINGS, MARCH, 1874.

Name of Road.	Mileage. 1874.	1873.	Inc.	Dec.	Per c.	Earnings. 1874.	1873.	Increase.	Decrease.	Per c.	Earnings per Mile. 1874.	1873.
Atlantic & Great Western	571	539	32	.....	6	$ 402,317	$ 420,250	.....	$ 17,933	4¼	$ 705	$ 780
Burlington, Cedar Rapids & Minnesota	424	334	90	.....	27	88,016	85,561	$ 2,455	.....	2¾	208	256
Central Pacific	1,218	1,218	.....	.....	.....	867,666	939,778	.....	72,112	7¾	712	772
Chicago & Northwestern	1,430	1,404	26	.....	1⅞	1,039,986	967,258	72,728	.....	7½	727	689
Chicago, Danville & Vincennes	157	132	25	.....	19	50,098	49,773	325	.....	0¾	319	377
Cleveland, Columbus, Cin. & Ind.	470	470	.....	.....	.....	318,976	441,386	.....	122,410	28¾	679	939
Erie	971	971	.....	.....	.....	1,413,223	1,628,742	.....	215,519	13¼	1,455	1,677
Illinois Central	1,109	1,109	.....	.....	.....	567,554	660,759	.....	93,205	14¼	512	596
Indianapolis, Bloomington & W't'n	344	319	25	.....	7¾	151,186	112,569	38,617	.....	34¼	439	353
Kansas Pacific	761	672	89	.....	13¼	245,774	300,719	.....	54,945	18¼	323	448
Marietta & Cincinnati	284	284	...	...	...	161,031	180,467	.....	19,436	10¾	567	635
Michigan Central	787	715	72	.....	10	615,930	690,017	.....	74,087	10¾	783	965
Milwaukee & St. Paul	1,236	1,121	115	.....	10¼	576,260	555,287	20,973	.....	3¾	466	495
Missouri, Kansas & Texas	784	641	143	.....	22¾	258,6 0	256,719	1,881	.....	0¾	329	400
Mobile & Ohio	517	517	.....	.....	.....	174,968	260,127	.....	85,159	32¾	338	503
Ohio & Mississippi	393	393	.....	.....	.....	297,613	330,998	.....	33,385	10¼	757	842
St. Louis, Alton & Terre H., main line	266	266	.....	.....	.....	104,193	122,299	.....	18,106	14¾	392	460
" " " branches	71	71	.....	.....	.....	44,482	53,420	.....	8,938	16¾	627	752
St. Louis & Iron Mountain	310	289	21	.....	7¼	169,475	224,449	.....	54,974	24½	547	777
St. Louis, Kansas City & Northern	507	583	...	76	13	201,213	229,925	.....	28,712	12½	397	394
St. Louis & Southeastern	349	349	.....	.....	.....	107,971	114,423	.....	6,452	5⅝	309	328
Toledo, Peoria & Warsaw	237	237	.....	.....	.....	98,022	102,491	.....	4,469	4¼	414	432
Toledo, Wabash & Western	628	628	.....	.....	.....	4' 4,699	471,301	.....	66,602	14¼	644	750
West Wisconsin	197	197	.....	.....	.....	74,958	74,537	421	.....	0¾	380	378
Total	14,021	13,459	638	76	.....	$8,434,211	$9,273,255	$137,400	976,444	.....	$602	$689
Total increase or decrease	.....	.....	562	.....	4¼	.....	.....	.....	839,044	9	.....	.....

RAILROAD EARNINGS, THREE MONTHS ENDING MARCH 31.

Name of Road.	Mileage. 1874.	1873.	In.	Dec	Per c.	Earnings. 1874.	1873.	Increase.	Dec.	Per c.	Earnings per mile. 1874.	1873.	Inc.	Dec	Per c.
Atlantic & Great Western	571	539	32	...	6	$1,154,613	$1,155,723	.....	$1,110	0¾	$2,022	$2,144	....	122	5¾
Burlington, Cedar Rapids & Minn.	424	334	90	....	27	277,532	227,541	$49,989	.....	22	655	681	...	26	3¾
Central Pacific	1,218	1,218	....	.....	.....	2,510,224	2,521,061	.....	10,837	0¾	2,061	2,070	....	9	0¾
Chicago & Northwestern	1,430	1,404	26	...	1⅞	2,936,497	2,484,975	451,522	.....	18¼	2,053	1,770	283	....	16
Chicago, Danville & Vincennes	157	132	25	....	19	150,307	146,395	3,912	.....	2¾	957	1,109	....	152	13¾
Cleveland, Col., Cin. & Indianap.	470	470	....	....	.....	964,663	1,203,272	.....	238,609	19¾	2,052	2,560	....	508	19¾
Erie	971	971	....	....	.....	4,149,648	4,279,148	.....	129,500	3¼	4,263	4,407	....	144	3¼
Illinois Central	1,109	1,109	....	....	.....	1,685,559	1,860,429	.....	174,870	9¾	1,520	1,678	....	158	9¾
Indianapolis, Bloomington & W.	344	319	25	....	7¾	432,611	303,338	129,273	.....	42¾	1,263	951	312	....	32¾
Kansas Pacific	761	672	89	....	13¼	594,552	646,060	.....	51,508	8	781	961	....	180	18¾
Marietta & Cincinnati	284	284	....	....	.....	476,274	508,984	.....	32,710	6¾	1,677	1,792	....	115	6¾
Michigan Central	787	715	72	....	10	1,806,423	1,707,923	98,500	.....	5¾	2,295	2,389	....	94	4
Milwaukee & St. Paul	1,236	1,121	115	....	10¼	1,888,160	1,313,718	574,442	.....	43¾	1,528	1,172	356	....	30¾
Missouri, Kansas & Texas	784	641	143	....	22¾	740,980	681,751	59,229	.....	8¾	945	1,064	....	119	11¼
Mobile & Ohio	517	517	....	....	.....	682,243	838,603	.....	156,360	18¾	1,320	1,622	....	302	18¾
Ohio & Mississippi	393	393	....	....	.....	802,291	913,960	.....	111,669	12¼	2,041	2,326	....	28.	12¼
St. Louis, Alt. & T. H, Main Line.	266	266	..	..	.....	287,425	350,092	.....	62,667	17¾	1,081	1,316	....	235	17¾
" " " Branches.	71	71	....	....	....	120,723	146,585	.....	25,862	17¾	1,700	2,064	....	364	17¾
St. Louis & Iron Mountain	310	289	21	....	7¼	475,210	522,337	.....	47,127	9	1,533	1,807	....	274	20¾
St. Louis, Kansas City & Northern	507	583	....	76	13	556,994	640,097	.....	83,103	13	1,098	1,098	....	....	....
St. Louis & Southeastern	349	349	....	....	.....	319,318	299,374	19 944	.....	6¾	915	858	57	....	6¾
Toledo, Peoria & Warsaw	237	237	....	....	.....	277,170	265,440	11,730	.....	4¾	1,169	1,120	49	....	4¾
Toledo, Wabash & Western	628	628	....	....	.....	1,180,603	1,246,701	.....	66,098	5¾	1,880	1,985	....	105	5¾
West Wisconsin	197	197	....	....	.....	234,454	155,623	78,831	.....	50¾	1,190	790	400	....	50¾
Total	14,021	13,459	638	76	.....	24,704,474	24,419,132	1,477,372	1,192,030	.....	1,762	1,814	..	52	2¾
Total increase	.....	.....	562	....	4¼	.....	....	285,342	....	0¼	.....	.....	....	....	.....

March Earnings.

Our tables give the returns of twenty-four railroad companies for the month of March, and they are the most unsatisfactory we have ever published. Eighteen of the twenty-four show a decrease in earnings, and only four show an increase in earnings per mile, these increases being small in all cases. The lines which depend largely on the through traffic between the East and the West have doubtless suffered much more in net earnings than these figures would indicate, for the rates were so low as to leave in many cases no margin above expenses. Of these lines the Atlantic & Great Western lost 10 per cent. in gross earnings per mile, the Cleveland, Columbus, Cincinnati & Indianapolis more than 25 per cent., the Erie (which had the protracted strikes added to its troubles) 13 per cent, the Michigan Central 19 per cent. On the whole, with an increase of 4¼ per cent. in mileage, these twenty-four roads show a decrease of 9 per cent. in aggregate earnings and of 12¼ per cent. in average gross earnings per mile.

There is no mystery in this condition of things. The business of the country has not recovered from the catastrophe of last fall, and for through business, while traffic was considerably reduced in bulk by the prevailing dullness, rates have been needlessly and excessively low, on east-bound freight low almost beyond precedent, giving average through rates probably below the working expenses incurred in carrying it, and in some cases, we have been informed, so much lower as to absorb all the profits of local traffic and leave the road absolutely without net income for the past two or three months.

Turning to the returns for the first quarter of the year, the returns make a not unfavorable appearance, there being a decrease of less than 3 per cent. in the average earnings per mile. And for this period, and for March also, it must be borne in mind that the proportion of expenses to earnings, on those lines which have no or an inconsiderable through traffic—that is, wherever the bulk of the traffic has been done at regular rates—has been considerably smaller than last year. This is illustrated by a recent special report by the Illinois Central, which shows that this road, with gross earnings for the first quarter of this year about $175,000 less, has net earnings about $100,000 greater. But aside from the lesser price of materials and labor, the Northern railroads this year did not have to meet the immense extraordinary expense caused last year by the severe and protracted cold and snow.

The Purchasing Agents' Convention.

It will be seen by reference to our advertising columns that the first annual or preliminary convention of the purchasing agents of the railroads of the United States is called for 17th June, at the Grand Pacific Hotel in Chicago. It is within few years, comparatively, that the office of Purchasing Agent has been a distinct one—the business of such officer having usually been performed in connection with the duties of some other office, generally the Superintendent. As roads increased in length and in business, the duties of purchasing were placed in the hands of other officers, as the Vice-President, the Master Mechanic, the Auditor, etc., etc., till finally the purchases of the

trunk lines became so heavy as to demand the services of an officer for this business exclusively.

From a few in number, ten years ago, the number of purchasing agents has increased rapidly to the present time—the last number of the *Travellers' Official Guide* having a list of no less than 106 railroads which have the office of Purchasing Agent *per se*. These railroads embrace *all* of the most prominent lines of the country, and the purchases made by these officers daily are simply enormous. Many of these gentlemen count their purchases by thousands, and some by tens of thousands of dollars daily. It is therefore of paramount importance that the parties filling these offices should not only be shrewd in business talent, versatile in their knowledge of what are known as "railroad supplies," but that they should watch the markets closely, and be on their guard against "shoddy," which is as apt to be offered among railroad supplies as in other merchandise.

All railroad officers have found that stated conventions (yearly or oftener), if not absolutely necessary, as in some cases, are at least of great benefit in exchange of ideas, unity of action, and otherwise. So we find the presidents and superintendents meeting in the Railway Association of America, while other officers and employes have respectively the General Ticket Agents' Association, the General Freight Agents' Association, the Master Mechanics' and the Master Car-Builders' associations; while even the conductors and baggagemen of the United States have their associations, and some at least derive great benefit from them. For the same reasons, as we understand, the purchasing agents have called their preliminary convention.

It is of course premature to say what they will do till they meet, but it is safe to presume that a general conference concerning their duties, considered relatively to those of other railroad officers (a matter not as definitely settled as it might be, perhaps) will take place; comparison of notes with reference to prices; honest and dishonest dealers; safe or questionable manufacturers; equal standing (in some cases) with the jobber, in prices or discounts from the manufacturer, and various questions where unity of action might be of benefit to their respective companies, will fully employ their time.

Record of New Railroad Construction.

This number of the RAILROAD GAZETTE has information of the laying of track on new railroads as follows:

Washington City, Virginia Midland & Great Southern.—The *Danville Extension* has been extended southward 7 miles to within half a mile of the terminus in Danville, Va. *Painesville & Youngstown.*—This narrow-gauge road has been extended from Burton southeastward 3 miles to Middlefield, O. *Galveston, Harrisburg & San Antonio.*—Extended westward 5 miles to Flatonia, Tex. *Walla Walla & Columbia River.*—Extended eastward 6 miles to a point 16 miles west of Walla Walla, Wash. T.

This is a total of 21 miles of new railroad, making 503 miles completed in the United States in 1874.

Transportation in Congress.

In the House, on the 17th:

After the reference of several private bills to the Committee of the Whole, Mr. Rice, of Illinois, from the Committee on the District of Columbia, reported a bill authorizing the Washington City & Point Lookout Railroad to enter the City of Georgetown with its railroad through the City of Washington, and to build a bridge across the Potomac River above navigation to connect with the Washington Branch of the Baltimore & Ohio Railroad.

After a long discussion the bill was passed, with an amendment offered by Mr. Ward, of Illinois, requiring the removal of the track already laid between the Asylum building and the Potomac River.

In the House on the 20th:

Mr. Young, of Georgia, moved to suspend the rules and adopt a resolution reciting the necessity for a cheap system of water transportation, and directing the Committee on Railroads and Canals to report a bill for the opening up and improvement of the great natural water highways of the country, and their connection by artificial chan els, and making it the special order for May 14.

Mr. McCrary, of Iowa, Chairman of the Committee, remarked that such a scheme would involve the outlay of $500,000,000.

The rules were not suspended—Yeas 130, Nays 75—not two-thirds in the affirmative.

In the Senate on the 21st:

Mr. Scott, of Pennsylvania, called up the bill providing for the payment of the bonds of the Louisville & Portland Canal Company, the question being on agreeing to the amendments of the House of Representatives as amended by the Senate. Mr. Scott read from reports submitted by the Treasury Department during former sessions of Congress, and argued that the canal was now practically owned by the Government, 9,995 shares of the 10,000 being held by the United States.

The question was on concurring with the House Wheeler amendment, which required the ceding of jurisdiction by the Kentucky Legislature (which does not meet for two years) before assuming possession of the canal. Messrs. Edmunds, of Vermont, and Conkling, of New York, advocated retaining this amendment, which Messrs. Thurman, Morton and Stevenson opposed, and by a vote of 40 to 4 the amendment was struck out and the bill sent back to the House for its concurrence.

In the House on the 21st:

Mr. Hurlbut, of Illinois, from the Committee of Railways and Canals, submitted a long written report on the bill to charter a double track freight railway company from tidewater on the Atlantic to Council Bluffs on the Missouri River, and to limit the rates of freight thereon. Ordered to be printed and recommitted.

Master Car-Builders' Association—Circular of Inquiry.

TRUCK AND CAR-BODY CHECK CHAINS.

To Master Car-Builders and Foremen of Railway Car Shops:

GENTLEMEN.—The undersigned, a Committee appointed by the Master Car-Builders' Association, on the subject of Truck and Car-Body Check Chains, submit to you the following interrogatories, for the purpose of eliciting further information, to be reported at the eighth annual convention, to be held at Cincinnati, June, 1874.

We trust that your interest in the subject and a mutual desire to promote the usefulness of the Association, will insure an early reply, that your Committee may be able to make a valuable report.

First—Are truck and car-body check or safety chains used on the passenger equipment of your road; if so, how many to each truck; what is the size and quality of iron, and length of link; and at what angle would the truck stand to the car when the chains are drawn taut?

Second—At what point of frame of car body are the chains attached, relative to the point of attachment to the trucks?

Third—How are the chains attached to the trucks and car body respectively, and what is the size of iron in hooks, eyes, bolts or other fastenings used in securing chains to truck and car body?

Fourth—Are the trucks secured to the body of car by key through the centre-pin or king-bolt, or by any other appliance?

Fifth—What is the expense per car of applying check chains as used on your road, and do you consider the advantages obtained by using them sufficient to make it a paying investment?

Sixth—In case of accidents, where some or all of the wheels are off the track, do you consider it advantageous to have the car remain coupled together.

Seventh—Are the truck and car-body check-chains, as applied on your road, in your opinion, practically of any value in preventing destruction of property, loss of life, or injury to employees, in case of accident where trains are running at usual speed?

Eighth—Have instances come under your observation where check-chains were of service in saving life or property? If so, please state the number of instances, and give particulars where the result was most satisfactory, or was attended by interesting or peculiar circumstances.

Ninth—What portion of the passenger equipment of roads that are supplied with check-chains, with which you are familiar, do you consider of a reliable and valuable character?

Tenth—Are check-chains used on the freight equipment of your road, and would you recommend their use on all freight equipment?

Eleventh—In your opinion, can check-chains and their fastenings be applied to trucks and car-bodies so that they will be of value in preventing the destruction of property, and increase the safety of passengers and employees? If so, please describe the manner in which you would apply them—size of iron, length of link, point of attachment to car-bodies and trucks, respectively, &c., &c.

In your answers please do not confine yourself to the space allotted in this circular, but make any suggestions and give information that will assist the committee in making a valuable report.

Address H. O. Wadlie, Master Car-Builder of Illinois Central Railroad, Chicago, Ill.

H. O. WADLIE,
Master Car-Builder of Illinois Central Railroad,
W. J. CALAIS,
Master Car-Builder of Wilmington, Columbia & Augusta Railroad,
J. A. KING,
Master Car-Builder of Chesapeake & Ohio Railroad,
Committee.

General Railroad News.

ELECTIONS AND APPOINTMENTS.

—At the annual meeting of the Adrian & State Line Railroad Company in Adrian, Mich., recently, James Berry, W. S. Wilcox, E. L. Clark, F. R. Stebbins, A. N. Foote, Geo. Bruce, H. A. Angell, R. B. Robbins, and J. H. Fee were elected directors. The board elected James Berry, President and A. N. Foote, Secretary.

—At the annual meeting of the Green Bay & Minnesota Railroad Company in Green Bay, Wis., April 13, the following directors were chosen: David M. Kelly, George Sommers, Fred. S. Ellis, W. J. Abrams, M. D. Peak, Green Bay, Wis.; W. E. Peak, Fort Howard, Wis.; Henry Ketchum, New London, Wis.; Walter Scranton, E. A. Bradley, New York. Mr. Kelly is a new director, succeeding Samuel Marsh, Jr. The board subsequently elected Henry Ketchum, President; David M. Kelly, Vice-President: F. S. Ellis, Secretary; W. R. Hancock, Treasurer, and S. B. Kenrick, Superintendent. Mr. Kelly, heretofore Superintendent, succeeds George Sommers as Vice-President, and is succeeded by Mr. Kenrick, heretofore Assistant Superintendent. The other officers are re-elected.

—Mr. M. M. Greene has been chosen President and James A. Wilcox Secretary and Treasurer of the Columbus & Toledo Railroad Company.

—The first board of directors of the Union Railway & Transit Company of St. Louis is composed of J. N. Kinney, P. M. Shoemaker, P. W. Strader, William Taussig, and W. H. Clements.

—At the adjourned annual meeting of the St. Louis, Kansas City & Northern Railway Company in St. Louis, April 15, the following directors were chosen: James H. Britton, B. W. Lewis, R. E. Carr, E. P. Winslow, Lewis B. Parsons, James B. Eads, R. P. Tansey, St. Louis; Thomas A. Scott, Philadelphia; Solon Humphreys, Joseph A. Jameson, William Hoge, New York; Messrs. Hoge, Lewis, Tansey and Winslow are new directors. The board elected William Hoge President and James F. Howe Secretary. Mr. Hoge replaces J. J. Mitchell.

—At the annual meeting of the Paris & Decatur Railroad Company recently the following directors were elected: R. G. Hervey, W. Stuart, D. C. Stratton, D. Hitchcock, W. T. Sylvester, E. A. Buck, James Hunter, James A. Eads, H. Van Sellar, R. N. Parrish, J. J. Morton, P. Campbell. The board elected R. G. Hervey President; D. Hitchcock, Vice-President; W. Stuart, Auditor; J. J. Morton, Secretary and Treasurer, and J. Hunter, General Eastern Agent.

—At the annual meeting of the Cuyahoga Valley Railroad Company in Cleveland, O., April 15, the following directors were elected: Joseph Perkins, James Farmer, L. M. Coe, N. P. Payne, A. B. Stone, Cleveland, O.; D. L. King, J. F. Seiberling, Akron, O.; James A. Saxton, George Cook, Canton, O. Mr. Stillman Witt declined re-election as a director on account of ill health.

At the annual meeting of the Columbus & Hocking Valley Railroad Company in Columbus, O., April 14, the old board of directors was re-elected, as follows: W. B. Brooks, C. P. L. Butler, Theodore Comstock, Wm. Denison, Wm. Deshler, Isaac Eberly, John L. Gill, M. M. Greene, John Greenleaf, B. E. Smith, Columbus, O.; John D. Martin, Lancaster, O.; G. W. Pickering, Athens, O.; C. H. Rippey, Logan, O. The board subsequently re-elected the old officers, as follows: President, B. E. Smith; Vice President, M. M. Greene; Secretary and Treasurer, J. J. Janney; Superintendent Jno. W. Doherty; Auditor T. J. Janney; General Freight and Ticket Agent, E. A. Buell. At the stockholders' meeting there was considerable excitement and 29,152 shares out of 37,011 were voted on.

—At the annual meeting of the United States Railroad Mutual Life Insurance Association in Richmond, Va., April 15, Franklin Fairman was chosen President, and R. D. Keen, Secretary and Treasurer for the ensuing year.

—The East St. Louis Union Railway & Transit Company has organized by electing the following directors: W. P. Shoemaker, W. H. Clements, William Taussig, Edmund Allen, Edmund A. Allen and John B. Bowman. The board elected officers as follows: W. H. Clements, President; William Taussig, Vice-President; J. M. Thompson, Secretary and Treasurer.

—Mr. E. Collings, Superintendent of the Camden & Atlantic Railroad, has been appointed General Superintendent of the Wilmington & Reading Railroad, and will have his office at Coatesville, Pa. The appointment takes effect May 1.

—Mr. J. P. Pringle has been appointed Master Mechanic of the Denver Division of the Kansas Pacific and of the Denver Pacific and Denver & Boulder Valley lines, with office at Denver, Col., in place of L. Ames, who has resigned. Mr. Pringle has been for nearly four years Clerk of the Denver shops.

—Mr. A. S. Hewitt, trustee under the first mortgage, who is now in possession of the Montclair Railroad, has appointed Mr. G. W. N. Custis Manager of the road.

—Mr. Edward Taylor has been appointed Acting Agent of the Pacific Mail Steamship Company at San Francisco, in place of Capt. Edward Higgins, resigned.

PERSONAL.

—Col. James T. Tucker, for many years General Southern Agent of the Illinois Central Railroad in New Orleans and a prominent citizen of that city, very widely known and esteemed, died at his residence on the 15th inst. Colonel Tucker was a brother of Mr. Joseph F. Tucker, General Freight Agent of the Illinois Central.

—Mr. C. D. Spaids is no longer General Superintendent of the Pittsburgh & Western Company's Refrigerator Line.

TRAFFIC AND EARNINGS.

—The Utah Central Railroad carried during March 10,221 tons of freight, including 5,252 tons of coal and coke, and 2,023 tons of ore and bullion.

—The freight carried over the Utah Southern Railroad in March was 6,051 tons, of which 1,805 tons was coal and coke, and 1,979 tons of ore and bullion.

—The earnings of the Great Western Railway of Canada for the week ending March 27 were: 1874, £23,893; 1873, £24,548; decrease, £655, or 2⅔ per cent.

—The earnings of the Midland Railway of Canada for March were: 1874, $20,418; 1873, $18,884; increase, $1,534, or 8⅛ per cent.

—The earnings and expenses of the St. Louis, Kansas City & Northern Railway for the year 1873 were:

Passengers	$907,532 87
Freight	1,714,936 23
Mails, express, etc	132,725 13
Total earnings ($4,726 per mile)	$2,755,194 23
Expenses (75.66 per cent.)	2,084,664 12
Net earnings ($1,150 per mile)	$670,530 11

—The earnings of the Milwaukee & St. Paul Railway for the second week in April were: 1874, $152,300; 1873, $124,870; increase, $27,430, or 22 per cent.

—The earnings of the Pittsburgh, Fort Wayne & Chicago Railway as reported to the Secretary of State of Indiana, for the year 1873, were:

Earnings	$9,619,074 36
Expenses (63.38 per cent.)	6,097,041 99
Net earnings	$3,522,032 37

—The earnings of the Columbus, Chicago & Indiana Central Railroad for 1873, as reported to the Secretary of State of Indiana, were:

Earnings	$4,477,806 84
Expenses (94.79 per cent.)	4,244,624 12
Net earnings	$233,182 72

—The earnings of the Indianapolis & Vincennes Railroad for 1873 are reported to the Secretary of State of Indiana as follows:

Passengers	$ 95,256 21
Freight	146,189 05
Other sources	12,338 88
Total earnings ($2,169 per mile)	$253,784 14
Expenses (75.52 per cent.)	191,647 13
Net earnings ($531 per mile)	$62,137 01

—The shipments of through freight eastward over the Central Pacific Railroad for February were: from San Francisco, 8,623 tons; interior points, 664 tons; total 9,287 tons, or 929 car-loads. The principal items were: Barley, 7,368 tons; malt, 443 tons; tea, 379 tons; wool, 186 tons.

—The shipments of oil from Harrisburg, Pa., to New York, over the Allentown Line during March were 1,362 car-loads, or about 3,813,860 gallons.

—The coal tonnage of the Chesapeake & Ohio Canal for March was 6,140 tons and the accrued revenue $8,751.52. The canal was only open a part of the month.

—The receipts of bituminous coal at East St. Louis for the month of March were as follows:

	Car-loads.
Belleville & Southern Illinois Railroad	2,232
Ohio & Mississippi	1,364
St. Louis & Southeastern	939
Vandalia Line	723
Illinois & St. Louis R. R. & Coal Co.	701
Total, car-loads	5,959

—The earnings of the Lake Shore & Michigan Southern Railway for the first three weeks in March were: 1874, $932,154; 1873, $1,180,795; decrease, $248,641, or 21¼ per cent.

—The earnings of the Toledo, Wabash & Western Railway for the first week in April were: 1874, $104,844; 1873, $98,796; increase, $6,048, or 6⅛ per cent.

OLD AND NEW ROADS.

New Jersey Southern.

The Chancellor of New Jersey has decided to keep the road in the hands of the present Receiver, Mr. W. S. Sneden, instead of turning it over to the trustees for the first-mortgage bondholders. It is probable that an appeal will be taken from this decision.

The Receiver is making preparations for the summer travel, which is the chief and most profitable business of the road. In addition to the steamboat line from New York, arrangements have been made to run a steamboat line from Newark direct to Sandy Hook in connection with the Long Branch trains.

Cairo & Vincennes.

In the case of Winslow & Wilson against this company in the United States Circuit Court at Springfield, Ill., the Court has signified its intention of granting the plaintiffs' petition and appointing a Receiver to protect the property of the company pending the final decision of the Court as to enforcing a contractor's lien in favor of Winslow & Wilson, who claim a balance due them of nearly $764,000. The plaintiffs urge Hon. N. R. Casey and Charles Ridgeley as proper persons to be appointed. The defendant has not named any one, but has suggested to the Court that in lieu of the appointment of a Receiver a bond may be executed sufficient to secure to the plaintiffs any sum which may be awarded them by a final decree. The Court intimated that such a course might be taken if both parties are

willing, and that, if taken, the bond should be for at least $500,000.

Erie.

In London, April 16, the Erie Shareholders' Protection Committee sent a protest to the London Banking Association, requiring it, on pain of being held responsible, to suspend any use of funds derived from the recent sale of bonds until it is ascertained whether the issue was fraudulent, owing to concealment of the real accounts rendered by the Auditor to the President. The Erie officers in New York are reported to have consented to and approved such action.

The promised statement of the President of the affairs and accounts of the company has not yet been published. Mr. J. S. Hunichen, Chief Bookkeeper in the Auditor's office, who was ordered to make an abstract of the accounts, has resigned. His published letter of resignation says that he is convinced of the truth of Mr. Dunan's statement as to the condition of the accounts, that he opposed the alterations in the books and has not seen since any reason to alter his opinion. He therefore retires from his position, not wishing to act contrary to his convictions of right. Mr. Watson answered that he was not asked to change any figures or do anything except draw up a statement from the books.

Lake Shore & Michigan Southern.

The extensive drying sheds used for drying the lumber for the car shops in Cleveland, O., took fire on the morning of April 13, and the buildings and lumber were destroyed. The adjoining shops were saved with great difficulty. The loss is estimated at $30,000, on which there is no insurance.

East Alabama & Cincinnati.

In the suit of Henry Clews & Co. against Lee and Chambers counties, Ala., to recover interest on bonds issued in aid of this road, the United States District Court at Mobile has ordered a peremptory mandamus to issue to compel the levying of a tax sufficient to cover the judgment rendered in favor of the plaintiffs.

Iowa Pacific.

A mortgage has been executed to James F. Joy and J. M. Walker, trustees, to secure a loan made by a syndicate in London. The mortgage is for £690,000 ($3,450,000) being at the rate of $25,000 per mile on 138 miles of road, from the junction near Fayette. Ia., to Fort Dodge. The bonds to be issued will have 20 years to run.

Logansport, Crawfordsville & Southwestern.

The shops at Crawfordsville, Ind., with one passenger and seven box-cars, were destroyed by fire April 16. The loss is about $15,000 and is partly covered by insurance.

Gilman, Clinton & Springfield.

Messrs. Morton, Rose & Co. advertise in London papers of April 4, that in accordance with the agreement made July 1, 1871, with the Pittsburgh, Cincinnati & St. Louis and the Illinois Central Companies, 29 bonds of £200 ($1,000) each have been drawn for redemption at par in currency and would be purchased at their office in London after April 15 at £182 15s., per bond, with interest from March 1.

Port Huron & Lake Michigan.

A circular has been issued by a committee of bondholders protesting against the consolidation with the Peninsular Company, advising bondholders to refuse to fund their coupons, and recommending a foreclosure and sale of the road.

Shenandoah Valley.

A meeting of the stockholders was called to be held at Front Royal, Va., last week, but was prevented by an injunction issued on application of parties from Jefferson County, W. Va.

Painesville & Youngstown.

Trains are now running regularly to Middlefield, O., which is 25 miles from Painesville and some three miles beyond the late terminus in Burton township.

East St. Louis Union Railway Transit.

This company has filed its articles of incorporation with the Secretary of State of Illinois. Its object is to lay tracks to connect all the railroads running into East St. Louis with the bridge.

Union Pacific.

Mr. John H. Millard, a Government director, has presented to the Committee on Pacific Railroads of the House of Representatives a protest against the action of the Committee in vo ing to declare the Omaha Bridge a part of the road. He also presented a letter from President Dillon declaring that it will be impossible to pay the interest on the bridge bonds if the power to levy the present rates of toll is taken away. The Committee appointed a day when arguments will be heard, but it is not thought likely that it will recede from its action on the question.

Tehuantepec.

Announcement is made that the "Tehuantepec Railway Company," chartered by the State of Vermont and owners of the charter made to Emilio La Sere by the Mexican Government in 1867 and 1872, has let the contract for the construction of the railroad, harbors, warehouses, etc., with full equipment, the work to be begun by the 1st of August next and completed within two years. The contractor is Capt. D. E. Davenport, of Lansingburg, N. Y. In 1870, Engineer Williams, who was accompanied by Col. Eduardo Garay, as a Commissioner to represent the Mexican Government, made a survey and located the route, which has been adopted by his company and approved by the Mexican Government. It was based in part upon the surveys of Gens. Barnard and Sidell, in so far as they were deemed advantageous, and commences at Minatitlan, thirty miles from the Gulf, on the Coatzacoalcos River, and crossing the isthmus with but little deviation from an air-line to Salina Cruz, on the Pacific coast, the distance being 145 miles, while a branch from that place of seventeen miles will connect Salina Cruz with Tehuantepec, unless by a change of route the main line should be made to so diverge as to first touch the last-named point.

This will make a route to San Francisco shorter than that by way of Panama by 1,133 miles from Liverpool, 1,477 miles from New York, and 2,334 miles from New Orleans. It was designed many years ago by New York capitalists, among whom Mr. Marshall O. Roberts was prominent, who built what was then known as the Florida Railroad, from Fernandina southwest to Cedar Keys, as one link in the route, the intention then being to have three steamer lines—New York & Fernandina, Gulf of Mexico, and Pacific Coast—and two railroads—the Florida and the Tehuantepec—in the route to San Francisco.

Montclair.

Mr. W. A. Guest, the purchaser at the sale of April 4, has failed to comply with the terms of the sale, which required him to assume the mortgages and pay interest thereon, and the road has passed into the possession of Mr. Abram S. Hewitt, trustee under the first and second mortgages. Mr. Hewitt has appointed Mr. G. W. N. Custis, formerly superintendent, Manager of the road, with instructions to take charge of the property and prevent all trespassing thereon. Trains are now run from Montclair to the New Jersey Midland junction at West End, and through trains will be put on as soon as the right-of-way injunction obtained by J. H. Pratt and H. C. Spaulding can be dissolved or remitted.

Messrs. A. S. Hewitt and Marcus L. Ward, trustees under the first mortgage, and A. S. Hewitt, trustee under the second mortgage, request all holders of first or second mortgage bonds to send their names, with the amounts and numbers of their bonds, to the trustees' office, No. 111 Liberty street, New York, without delay.

North Pennsylvania.

The Northeast Pennsylvania road will, it is said, shortly be extended from its terminus at Hatboro, Pa., to the Delaware, whence the lately organized Delaware River & Bound Brook Company will extend it to the New Jersey Central at Bound Brook, N. J. The line from Hatboro to the Delaware will occupy a part of the route surveyed by the National Railway Company, and the new roads, if built, will complete a line from Philadelphia to New York very nearly the same as that projected by that now defunct organization. Several of the directors of the Delaware River & Bound Brook Company are connected with the North Pennsylvania.

Walla Walla & Columbia River.

The road is now completed for 16 miles westward from Walla Walla, W. T., and trains are running regularly over the line.

Milwaukee & St. Paul.

The new tariff of rates agreed upon with the Chicago & Northwestern, and which went into operation April 8, provides for the following rates between St. Paul and Milwaukee or Chicago: First class, 80 cents per 100 lbs.; second class, 70 cents; third class, 50; fourth class, 35; grain in car-loads, 30.

The pontoon which is to form the draw for the pontoon bridge over the Mississippi at Prairie du Chien has been launched. It is 408 feet long and 30 feet wide over all, and contains some 250,000 feet of lumber and five tons of iron.

The company is asking from Congress a special act to authorize the building of the La Crosse bridge on the site chosen by the company.

Grand Trunk.

The higher court has quashed the finding of the coroner of Quebec against Mr. Brydges, Managing Director, for the killing of a man run over on the road at Point Levi. The Court held that there was nothing to show that the Grand Trunk Company were legally compelled to keep a gate and guardian at the crossing, and that although the employes of railways can undoubtedly be tried for manslaughter for faults of omission as well as commission, it would only be for omitting to do something they were legally compelled to do.

Nevada County.

The corporators of the company which is to build the line from Nevada City, Cal., to Colfax have organized the company by the name of the Nevada County Railroad Company and have resolved to make the gauge 3 feet. There is some talk of building to Marysville to connect with the projected line from that place to Knight's Landing on the Sacramento River, instead of going to the Central Pacific at Colfax. The road will be an outlet for the flourishing quartz-mining districts of Grass Valley and Nevada.

Western Rolling Stock Company.

A company by this name, with a capital of $400,000, has filed articles of incorporation with the Secretary of State of Missouri.

Missouri & Illinois Rolling Stock Company.

Articles of incorporation have been filed with the Secretary of State of Missouri by a company organized under this name, with a capital of $200,000.

Missouri, Kansas & Texas.

Arrangements are being made to organize an all-rail through-freight line, mainly for cotton freights, from Galveston, Tex., to New York, over the Houston & Texas Central and Missouri, Kansas & Texas roads.

Western Texas Narrow Gauge.

A bill has passed the Texas Legislature extending by one year the time for commencing work. It is reported that negotiations are pending for the capital needed for the construction of the road, with some prospect of success.

Texas & New Orleans.

An amendment to the charter of this company has passed one branch of the Texas Legislature authorizing it to make connection with any road that may be built from New Orleans to Texas, and fixing the crossing of the Sabine River within a half mile of Orange.

South Side, of Long Island.

Recently Judge Donohue, of the New York Supreme Court, in a suit brought by E. L. Clinch against the company, issued an order appointing E. D. Gale Receiver and Aaron Degraw Superintendent of the road. Meantime General Tracy had obtained from the United States Circuit Court an order putting the company into bankruptcy, and on going to take possession, April 20, the Receiver found that the road was already in the hands of the United States Marshal. The Receiver threatened to stop the running of trains, but it was finally settled that the Marshal's deputies should remain in possession, the Receiver being allowed to put a clerk in charge to look after his interests.

Subsequently Judge Donohue issued an order to restrain the United States Marshal from interfering with the Receiver, but Judge Pratt, of the Supreme Court, issued another order restraining the Receiver from taking possession and ordering him to show cause why his appointment should not be vacated. Lastly, the United States District Court granted an order instructing the United States Marshal to operate the road for the benefit of the creditors. The Marshal took possession and appears likely to retain it though the case as it stands is a very pretty legal muddle.

Western North Carolina.

In the case of Hiram Sibley and Henry Clews against this company in the United States Circuit Court at Greensboro, N. C., the Court has made a decree ordering the road, equipment and franchise to be sold at public sale on 40 days' notice, to satisfy a mortgage for $1,200,000. The Court appointed as commissioners to make the sale Thomas B. Keogh, Greensboro, N. C.; Thomas Ruffin, Hillsboro, N. C.; B. S. Garther, Morganton, N. C., and Marcus Erwin, Asheville, N. C.

The road is in operation from Salisbury, N. C., westward 114 miles to Old Fort, and is intended to run to the Tennessee State line. The affairs of the company have been in litigation for several years and the road is in the hands of a receiver.

Southern Pacific, of California.

Work has been commenced on the extension from Delano, Cal., southward. The force now employed is small, but is soon to be increased. It is stated that work will be continued steadily until a connection is made with Los Angeles.

Cincinnati, Rockport & Southwestern.

Contracts have been let for the grading, ironing and equipment of the road, and work is said to be progressing rapidly. The company is selling five-year, 10 per cent. temporary loan bonds at the rate of $6,000 per mile, to supply the necessary funds for continuing the work.

Pennsylvania –New York Division.

Preparations are made for faster trains than have ever run heretofore between New York and Philadelphia. One of the new regular trains makes the trip in 2½ hours, which is at the average rate of 36 miles an hour, and the newspaper train, which is not held to time, is reported to have made the 90 miles on one occasion in two minutes less than two hours. The time is not so extraordinary, and the route, having the monopoly of the traffic between the two largest cities on the continent, would seem naturally to need the fastest trains; but it has never had them, but has been worked easily. Among other indications that greater speed will be arrived at hereafter are the preparations for putting in water troughs for "jerk waters" on the line. It would seem that a train running through between New York and Philadelphia without stopping at the fastest rate of speed might be made to pay; but in fairness the charge should be higher on such a train.

New York to Washington.

Under the new arrangement by which two trains are to run between New York and Washington by the Baltimore & Potomac and two by the Baltimore & Ohio, three trains leave New York at the old time, 8:40 a. m., 3 and 9 p. m. The trains leaving at 8:40 a. m. and 3 p. m. go by the Baltimore & Ohio, the 9 p. m. train and the new train at 9:30 a. m. going by the Baltimore & Potomac. The new train which has been added is called the "Washington Limited Express," which leaves New York at 9:30 a. m. and reaches Baltimore at 2:55 and Washington 4:10 p. m., making the run of 235 miles in six hours and 40 minutes, the fastest regular time ever made between the two cities. This train consists entirely of Pullman coaches, and the fare charged on it is to Philadelphia, $4.25; to Baltimore, $8.50, and to Washington, $10, being an extra charge to Philadelphia of $1, to Baltimore of $2.30 and to Washington of $2.50.

Lake Superior & Mississippi.

The St. Paul (Minn.) *Press*, of April 14 says:

"The long mooted question as to who is to hereafter operate and own the Lake Superior & Mississippi Railroad will be decided to-day, (according to reliable advices from the East,) by the formal surrender of the road and franchises back into the hands of the old stockholders. It is positively alleged that all the details of the surrender of this line by the Northern Pacific Company have already been fully agreed upon and that the stockholders are to assume complete possession on and after this date. As an indication that the thing is now 'a bird' after a somewhat protracted delay, the fact may be stated that thirteen new locomotives for the Lake Superior and Mississippi line have been purchased. It is further stipulated in the agreements to be signed to-day at Philadelphia, that the indebtedness of the road to the Northern Pacific Company is to be cancelled at the rate of $35,000 a year in rental for the use of that portion of the Lake Superior and Mississippi road between Duluth and the Junction—the Northern Pacific Company to have the right to operate their cars over this portion of the surrendered line at the annual price above specified for a term of years. The old stockholders propose to make up the balance of the indebtedness due the Northern Pacific Company from the sale of lands."

Sabula, Ackley & Dakota.

It is reported that work will be commenced in June on the extension of the road westward from the present terminus at Marion, Ia.

Cumberland & Ohio.

The work recently advertised between Eminence, Ky., and Greensburg and between Glasgow, Ky., and Scottville, Tenn., has been let to the following contractors: Reid & Lewis, sections 87, Shelby County, 38 and 43, Allen County, 48, 49, 51, 58, Barren County; Michael Dolen, sections 64, Spencer County, 92, Shelby County, 47, Barren County; Morris, McMichael & Co., sections 52, 53, Barren County; Nunan, Bartly & Gordon, section 65, Spencer County; M. & J. N. Tabler, section 66, Spencer County; McCann & Wigglesworth, section 67, Spencer County; Lyter & Prewitt, section 86, Shelby County; Michael Burke, section 88, Shelby County; Samuel Black, section 37, Allen County; Bibb & Walker, section 44, Allen County; M. Shea & Co., section 46, Barren County; R. E. Childs, section 54 Barren County; James Morrison, section 56, Barren County. The whole work comprises about 40 miles of road.

Chicago & Southwestern.

Suit has been brought in the New York Supreme Court by Wm. Eck and Charles Fries, holders of some of the Atchison Branch bonds, which are a first mortgage on the branch and a second on the main line, and three coupons on which are unpaid, against the Chicago & Southwestern and the Chicago, Rock Island & Pacific companies and the trustees under the mortgage. The complainants claim that the guarantee of the Chicago & Southwestern bonds given by the Chicago, Rock Island & Pacific Company was understood to extend to the Atchison Branch bonds also and was so announced by the trustees. The suit is brought to recover on the coupons.

Atlantic, Mississippi & Ohio.

The committee of the Virginia House of Delegates appointed to investigate the affairs of this company has reported that nothing has been discovered to sustain any of the injurious allegations made concerning the company, and that it appears that the funds derived from the sale of the first-mortgage bonds have been expended on the improvement of the road as required by the charter.

Dividends.

The Boston and Albany Railroad Company has declared a semi-annual dividend of 5 per cent., payable May 15.

Allegheny Valley.

The annual meeting, which was to be held in Pittsburgh, April 14, was postponed to April 24 on account of the death of the President, Mr. Phillips.

United States Railroad Mutual Life Insurance Association.

The annual convention of this association was held in Richmond, Va., April 15, 31 delegates being present. The President's annual report was submitted at the morning session, and gives in detail the operations of the association during the past year. The organization has paid out $89,000; expenses, $8,500. At this date there are 2,077 active members. At the night session Cincinnati was selected as the place of the next meeting.

Central, of Iowa.

Mr. C. C. Gilman, formerly President, has issued a circular in reply to the circular of Mr. Cate, the present President, published some weeks since. He criticises the present management, under which, he claims, the property has depreciated and the condition of the road become desperate.

Rutland.

It is reported that the Central Vermont Company has made a proposition looking to a modification of the lease of the Rutland Railroad, and negotiations are said to be now in progress.

Southern Minnesota.

A motion to dismiss the petition to have the Company declared a bankrupt has been denied by the United States' District Court, which held that the acts of bankruptcy as charged appeared sufficient.

Cincinnati Southern.

The trustees advertise that proposals will be received until May 20 at the American Exchange National Bank in New York for $1,000,000 of Cincinnati City 7.30 bonds, the proceeds of

which are to be used in the construction of the Cincinnati Southern road. The bonds are redeemable in 1902, and the interest is payable semi-annually in New York. In addition to the ordinary security given by a city bond, these bonds are further secured by a special lien upon the whole line of road to be constructed from Cincinnati to Chattanooga, Tenn.

Buffalo & Jamestown.

The commissioners of the towns of Jamestown, Eden, Collins, Persia and Cherry Creek, which have been bonded in aid of the road, have presented a protest against any diversion of the road from the original line from Buffalo to Jamestown, and against any plan which does not include the completion of the road to the latter place.

Buffalo, New York & Philadelphia.

A circular has been issued to the stock and bondholders offering to them first the $500,000 remaining unsold of the issue of $1,000,000 10 per cent. second-mortgage bonds. The price named is 95.

Peoria, Atlanta & Decatur.

Tracklaying is in progress from Atlanta, Ill., northwest, and is being pushed forward rapidly in order to secure some township aid which lapses May 1. Work on the bridge at Mackinaw is progressing. The grading from Atlanta southeast to Decatur is all finished except about two miles near Waynesville.

Rochester, Nunda & Pennsylvania.

The bill authorizing the city of Rochester, N. Y., to issue at once the remaining installments of the bonds voted in aid of this road has become a law. Sufficient subscriptions have been secured to the stock of the construction company which is t. complete the road to organize the company. Arrangements are being made to resume work at once and to purchase iron.

Toledo, Wabash & Western.

The new elevator at Toledo, O., which will have a storage capacity of 1,200,000 bushels, is very nearly completed.

Northern Pacific.

The meeting of the bondholders which was to be held in New York, April 21, to elect a new trustee or trustees under the mortgage was postponed on account of informality in the call.

New York & New England.

At an adjourned meeting of the stockholders in Boston, April 21, the committee appointed to confer with the trustees in possession of the road made a partial report an asked for more time, which was granted. The committee also asked authority to borrow money, not to exceed $800,000, to pay the debt of the trustees, the receivers' certificates of indebtedness and the amount contributed by certain bondholders. The stockholders voted to authorize the loan, and then adjourned to May 5.

Philadelphia & Erie.

The spring trade has now fairly opened with the Lake and the present business is fully equal to what it has been heretofore at this season, with every indication of an increase and continuance through the summer. Heavy shipments of grain are being made by the Empire Transportation Company over the road, the grain coming from Chicago and being bound for Liverpool. Local lumber traffic is also quite heavy. It is expected that on the opening of the Eastern Extension of the Allegheny Valley the capacity of the eastern end of the road will be heavily taxed.

The bridge over Sinnemahoning Creek at Cameron was burned April 14. It was about 280 feet long, in two spans. Owing to a flood in the creek and the rafting of logs there was a delay of several hours in putting up trestles, but the creek was spanned by a temporary trestle work and trains crossed at 6:30 p. m., on the 15th, about 36 hours after the fire.

Detroit Bridge Question.

A convention of vessel-owners of the lake ports met in Detroit, Mich., April 15, to take action on the question of the proposed bridges over the Detroit and St. Clair rivers. Nearly 200 delegates were present. Captain William Edgar, of Chicago, was elected President, and the convention was made a permanent organization, to be called the "Northwestern Association of Vessel-Owners." Several resolutions and memorials were presented and considered, and resolutions were passed protesting against any law permitting the building of a bridge over the Detroit or St. Clair River, recognizing the necessity of speedy transit between the American and Canadian shores, and endorsing the recommendation of the Government engineers favoring a tunnel under the river of Detroit as the best and fairest mode of solving the difficulty.

Valley, of Virginia.

About 1,400 hands are at work between Staunton, Va., and Salem, and work is going on along the whole line.

It is stated that at a recent meeting of the directors in Baltimore a proposition was received from the Baltimore & Ohio Company to lease the road from Harrisonburg to Salem for a fixed percentage of the earnings. This was declined and a committee appointed to consider and report on the expediency of leasing the road or the best method of running it.

Houston & Texas Central.

Negotiations are said to be in progress between this company and Mr. Charles Morgan, the large steamship owner and proprietor of the railroad from New Orleans to Berwick Bay, for a direct connection between the Texas Central road and the Morgan steamship line. It is believed that this will be done by dredging out the bayou so that the steamers can run up to Green's Bayou, 15 miles below Houston. From Houston to Green's Bayou an extension of the Central road can easily and cheaply be built.

Des Moines Valley.

The equipment of the old road has been finally divided between its two successors, and the old company and its name may now be considered as finally out of existence. The Keokuk & Des Moines takes 15 engines, 4 baggage, 1 smoking and 6 passenger cars and two-thirds of all the freight cars. The Des Moines & Fort Dodge receives as its share 9 engines, 2 baggage, 1 smoking and 3 passenger cars and one-third of the freight cars.

Pacific Mail.

A report recently published, but bearing date January 26, gives a list of the company's steamers with notes of the condition of each. The report names 29 steamers (not including the new iron vessels) of which 12 are reported in fair condition, 10 in poor condition, and seven either condemned or worn out and not worth repairing. All of those reported as being in fair condition require more or less extensive repairs to make them fit for continued service.

North Shore of Canada.

The Toronto (Ont.) *Monetary Times* says:

"The following are the official terms of the final arrangements with the Hon. Mr. McGreevy, the new contractor of the North Shore Railway. The price of the contract is fixed at $7,000,000, payable in the following manner: Corporation of Quebec debentures, $1,000,000; Government bonds, $1,248,634; Railway 1st preferential bonds, $4,751,366; total, $7,000,000. All stock bonuses to be abandoned. The changes made in the contract are the extension of the line with double track from Palais Harbor to deep water River St. Lawrence. Limit of amount of right of way payable by the contractor to be increased from $1,100,000 to $1,500,000. The necessary wood sheds and snow fences to be provided. An additional sum of $5,000 per annum is to be for the company's expenses. Issue of first preferential bonds to be limited to five millions. Bonds to the amount of $249,634 to be reserved by the company in order to enable the contractor to make provision for the first six months' interest on the first preferential bonds after the completion of the road. The period of completing the main line to be extended to the 1st of December, 1876. The work of construction to be commenced immediately after the signing of the contract, and to be proceeded with continuously to the satisfaction of the Chief Engineer of the company. The directors having the right to cancel the contract if the work is not commenced within six months from the signing of the contract, and proceeded with continuously thereafter."

Opening Lake Rates at Chicago.

Although navigation is not open through the Straits of Mackinaw, a great many vessels are being chartered for grain, the ruling rates being apparently 5 cents for corn and 5½ for wheat by sail to Buffalo; a charter at 37½ per hundred for wheat by sail to Erie and railroad to New York is reported, being at the rate of 22½ cents per bushel through. The lake rates are very low, nearly down to the usual midsummmer rate.

Nova Scotia Railroad Subsidies.

The Toronto (Ont.) *Monetary Times* says:

"The Nova Scotia Government have come down with a railway policy. They propose to subsidize the companies building the western extension lines with $6,000 per mile and eastern extension lines $5,000 per mile. The Provincial Secretary said the Dominion Government had signified its willingness to hand over the present Nova Scotia lines to the local Government for the purpose of extending them further east and west."

Western Counties.

This road is under contract for about 18 miles from Yarmouth, Nova Scotia, northward. Negotiations are going on for the capital required in addition to the subsidies received and stock subscriptions already secured. The road will be an extension of the Windsor & Annapolis road from Annapolis, N. S., southward to Yarmouth, near the extreme southwest point of the peninsula.

Syracuse Northern.

Arrangements are being made to commence work on the extension of this road, which is to run from Sandy Creek, N. Y., north to Henderson Harbor, and thence on the old grade of the Sacketts Harbor & Pierrepont Manor road to Sacketts Harbor. The extension will be about 25 miles long.

Nevada County.

Savannah, Griffin & North Alabama.

An officer of the company informs us that of the extension from Newnan, Ga., to Carrolton, 11 miles, to Whitesburg, was completed in December, 1872. In October, 1873, six miles further was completed, bringing the road to its present terminus 7 miles from Carrolton. An unexpected delay in getting iron has kept the work back, but arrangements have been made for it and the road will probably be opened to Carrolton in July or August.

Hamilton & Northwestern.

This road is to receive an additional subsidy of $500 per mile from the Ontario Government, on 44 miles of its line, making its subsidy $3,000 per mile for that distance and $2,500 for the remaining 86 miles. The company has now in Government grants, $346,250; municipal bonuses, $512,450; stock subscriptions, $250,500; total, $1,109,200. It is proposed to issue bonds to cover the balance of the estimated cost of the road.

Maryland Railroad Legislation.

Among the bills thus far passed by the Maryland Legislature are the following:

Act to amend the charter of the Worcester & Somerset Railroad Company.

Act to empower the Frederick & Pennsylvania Line Railroad Company to lease its road.

Act to enable the Mayor and City Council of Baltimore to subscribe to the Washington City & Point Lookout Railroad and the Southern Maryland Railroad Companies.

Act to amend act to incorporate the Bachman Valley Railroad Company, authorizing and empowering the President and Directors to issue the bonds of the said Company to an amount not exceeding $50,000.

Acts to approve the act of 1872 to authorize the County Commissioners of Calvert and Anne Arundel Counties to subscribe to the capital stock of the Baltimore & Drum Point Railroad Companies as provided by section 54, article 2 of the Constitution.

Rio Grande.

The Secretary of this company informs us that this road, which is in the southernmost point of the United States and very near the tropic, is of 3 ft. 6 in. gauge and 22 miles long, extending from the Gulf of Mexico at Point Isabel in the harbor of Brazos Santiago, about 2½ miles from the bar, westward to the Rio Grande, at Brownsville, Texas, opposite Matamoras, Mexico. The locomotives are from the Baldwin Locomotive Works, and the cars, both passenger and freight, by the Jackson & Sharpe Company of Wilmington, Del. Mr. Joseph Kleiher, the Secretary, to whom we are indebted for this information, says: "We run daily freight trains, bringing up merchandise arriving from New York, New Orleans, and Europe direct. On Sundays we run regular excursion trains, which are well patronized by the people of Matamoras and Brownsville."

Central of New Jersey.

The annual report gives the following account of the new construction during 1873:

No new work has been commenced on the main line, but the straightening of tracks and relaying with steel have been continued. The tangent line between Westfield and Plainfield is ready for the rails, which were not laid last fall, owing partly to the panic and partly to the lateness of the season. The plans for the elevation through Plainfield have been settled, and that work will soon be pushed.

During the current year the laying of steel rails will be continued, and 5,000 tons are already contracted for this purpose. During the past three years 105 1-10 miles of steel rails have been laid in the main tracks of the Central Division, and 41 miles in the main tracks of the Lehigh & Susquehanna Division, a total of 146 1-10 miles. Added to this is the 45½ miles between Easton and Mauch Chunk, laid by the old company before that road was leased, or a total of 191 6-10 miles of steel in the main line. Within the same period the cross-ties of the main line have been entirely renewed; hence the expenditure for new ties and iron rails must be comparatively light for the next four to six years. From this source will come the largest reduction of the expenses of operation and maintenance.

The steel rails are wearing well, and there have been very few broken or defective ones. The failures have been caused by hidden defects, with very few exceptions.

On the Lehigh & Susquehanna Division the second track has been considerably advanced. There are now on this division 105.40 miles single track, 27.63 miles second track, 72.49 miles of branches and 85.29 miles of sidings, making in all 290.81 miles of single track. During the present year work on the second track will be continued at the most important points.

Atlantic & Great Western.

It is reported that the Shenango Branch will be extended this season from Harrisville, Pa., southeast through the new Butler oil district to Brady's Bend on the Allegheny Valley road, passing through Petrolia and Martinsburgh. The distance is about 27 miles.

Ashtabula, Youngstown & Pittsburgh.

An Ashtabula (O.) correspondent of the Pittsburgh *Commercial* reports that the Pennsylvania Company has closed an arrangement with Rhodes & Co., of Cleveland, the great coal and ore dealers of the lakes, by which a branch of their business will be established at Ashtabula harbor, the lake terminus of the road, where extensive dock improvements have been made.

Baltimore & Annapolis.

The bill chartering a company to build a direct line etween Baltimore and Annapolis passed the Maryland Legislature, but failed to receive the governor's signature, the reason given being that no special charter is required, as the company could organize under the general law.

St. Louis & Southeastern.

This company paid over to the Tennessee State Treasurer, April 14, $15,000 in State bonds, being a payment on account of the purchase money of the Edgefield & Kentucky road.

St. Louis Union Railway & Transit.

This company filed its certificate of incorporation with the Secretary of State of Missouri, April 13. The capital stock is to be $250,000, and the object of the company is to build and operate a railroad from the Illinois shore across the bridge and through the tunnel to some point on Poplar street in St. Louis.

New York, New Haven & Hartford.

The next Connecticut Legislature will apparently have plenty of business which concerns this company. Notice has been given, as required by law, that the following applications will be made to the Legislature at its next session: For the repeal of the act of 1839, authorizing the New York, New Haven & Hartford Railroad Company to run or own steamboats; to prohibit the company from making contracts for freight and passengers with any steamboat company; to prohibit the company from collecting wharfage in New Haven; to require the company to take up their side track in that city from the tin bridge to the steamboat wharf; to prohibit the company from exercising any riparian rights; to require them to pay city and town taxes on all their property in New Haven, except their continuous track through the town and a single freight and passenger depot, and to impose the same restraints on the company in that city as are imposed in Hartford.

Green Bay & Minnesota.

About a mile of iron has been laid on the new branch to the river opposite Winona, Minn. The elevator, dock and freight house are being pushed forward.

The company has made arrangements with the Diamond Jo. Steamboat Line for through rates between points on the Mississippi and Green Bay.

Delaware River & Bound Brook.

The line from Bound Brook, N. J., to Moore's Landing is being finally located, and work will, it is said, be commenced in a few days.

New Jersey Midland.

The business of the road is steadily increasing, and the company is adding to the equipment as fast as possible. Six passenger, three mail and baggage, five milk, and 25 box cars are being built and will soon be on the road.

Washington City, Virginia Midland & Great Southern.

The track of the Danville Extension has been extended seven miles southward and has now reached the end of the grade, which is about half a mile from the intended terminus at Danville. The grading of this half mile is under contract and is being pushed forward rapidly.

Galveston, Harrisburg & San Antonio.

The track has been laid to Flatonia, Tex., 35 miles west of Columbus and five miles beyond the last point noted. The company has contracted for the labor of a large number of convicts, who will be employed on the grading.

Illinois & St. Louis Bridge.

The iron work of the bridge was completed April 15, and the Keystone Bridge Company, the contractor, gave a dinner to its workmen in celebration of the event. The work has been completed 15 days in advance of the contract time, for which the contractor receives a bonus of $1,000 per day. Work on the approaches will be hastened to completion as rapidly as possible.

Richmond & Danville.

This company has made application to the Virginia Legislature for authority to change the gauge of the road from 5 feet to 4 feet 8½ inches. The proposition meets with much opposition in Richmond. The change of gauge on this road would be very likely to be followed by a similar change on the Atlanta & Richmond Air Line.

North Carolina.

At the special meeting held in Salisbury, N. C., April 16, it was voted to accept the act of the Legislature providing for a consolidation with the Atlantic & North Carolina and Western North Carolina companies and the completion of the latter road to the Tennessee line. The act also provides that the gauge of the road may be changed, but not until the Western line is finished. It is probable, however, that the present lessee (the Richmond & Danville) has abandoned the intention of changing the gauge.

Atlantic & North Carolina.

A lease of this road has been made to the Midland North Carolina Railroad Company. The lease is said to be for 50 years at a rental of $16,000 per annum. It was finally executed April 11, but will not probably stand without much litigation. On behalf of the State of North Carolina, which owns, we believe, a two-thirds interest in the stock, Governor Caldwell procured an injunction, but the lease was executed before it could be served on the company. The Governor subsequently ordered the removal of Mr. Stanly, the President, and three of the directors. The lease seems to have been made to prevent, if possible, the consolidation with the North Carolina Company.

The Midland North Carolina Company owns no road. The Atlantic & North Carolina road extends from Goldsboro, N. C., southeast to Morehead City, 95 miles.

Cincinnati, Sandusky & Cleveland.

An informal meeting of the Boston stockholders was held April 16, at which the President presented a report of the Sloane investigation, and a vote was passed looking toward rendering the stock held in the Columbus, Springfield & Cincinnati Railroad available as as ets.

Summer Time Tables.

A convention of superintendents met in St. Louis April 15, at which all the through lines were represented. Mr. E. S.

Flint, General Superintendent of the Cleveland, Columbus, Cincinnati & Indianapolis, was chosen President, and E. A. Ford, of the Atlantic and Pacific, Secretary. A resolution to adopt the present through-line schedules for the summer schedules was referred to a committee of fifteen, which reported as follows: "That the resolution be modified to read as follows: That the present schedule between St. Louis and New York be adopted for this summer's schedule, and that the time between New York and Chicago shall be as follows:

"Leave New York: westward, via New York Central, 10 a. m. and 8 p. m. Arrive at Chicago at 8 p. m. and 8 a. m. Leave New York, via Pennsylvania Railroad, 9:30 a. m. and 8:30 p. m. Arrive at Chicago 7:30 p. m. and 8:30 a. m., or 8:15 a. m. Leave Chicago eastward, via New York Central, 9 a. m. and 5:15 p. m. Arrive at New York 7 p. m. and 7 a. m. Via Pennsylvania Railroad: Leave Chicago 9 a. m. and 5:15 p. m. Arrive at New York 6:30 p. m. and 6:30 a. m. No change shall be made from the present time table by lines from the southwest until after due notice to all competitors. The changes of time recommended shall take effect May 24, 1874. The committee will report through its secretary the time at intermediate points, if desired."

The report was received and adopted, and after some routine business the convention adjourned.

Baltimore & Ohio.

An agreement has at last been made with the Pennsylvania Railroad Company which will put an end for the present to the war which has been going on between the two companies for some time past. The first proposition for a settlement was made about a month ago, when the Pennsylvania offered to haul two trains daily through to New York for the Baltimore & Ohio, provided the latter would make a connection with the Baltimore & Potomac near the Relay House, so that all the trains should pass through the Baltimore tunnel. This was refused, but subsequently the present agreement was negotiated. By this the Baltimore & Ohio restores rates of freight and fare to the old standard in force when the war commenced. The Pennsylvania Railroad Company agrees to haul two Baltimore & Ohio trains daily each way between West Philadelphia and Jersey City, and agrees also to sell through tickets west over the Baltimore & Ohio and to give the latter all necessary facilities for through freight.

Under this arrangement, there will be four daily trains between New York and Washington; two day trains by the Baltimore & Ohio, one day and one night train by the Baltimore & Potomac.

It remains to be seen whether this is a permanent peace or merely a truce between the contending parties.

[Entered according to Act of Congress, in the year 1874, by the RAILROAD GAZETTE, in the office of the Librarian of Congress, at Washington.]

THE CATECHISM OF THE LOCOMOTIVE.

BY M. N. FORNEY, *Mechanical Engineer.*

PART IX—(CONTINUED).

THE THROTTLE-VALVE AND STEAM PIPES.

QUESTION 152.—*How are the steam-pipes constructed?*

Answer.—The steam, after it is admitted by the throttle valve, as was explained in answer to Question 113, passes into the throttle-pipe *I* and the dry-pipe *m m*, fig. 44. At the front end of the dry-pipe a pipe *n*, figs. 43 and 44, which divides into two branches like the top of the letter *T* and is therefore called a T pipe, is attached. The steam-pipes *o o*, fig. 43, are connected to each of the two branches of the *T* pipe at one end and to the cylinders at the other.*

These pipes, being in the smoke-box, are exposed to great changes of temperature, and are therefore subjected to expansion by heat and contraction by cold. The joints are therefore constantly subject to disturbance by the contraction and expansion of the pipes and so are difficult to keep tight. It is also practically impossible to construct the boiler, the cylinders and the pipes with perfect accuracy, and therefore a small amount of adjustability and flexibility is necessary in the joints of the pipes. If, for example, the opening *x* in the cylinder, fig. 43, were either too near or too far from the cylinder of the engine, it would be necessary to move the end of the pipe *o* either to the right or to the left in order to connect it with *x*. If the joint of the upper end of the steam-pipe were attached to the T pipe with a flat joint like that shown at *a b*, fig. 87, it would be impossible to move the lower end of the steam-pipe either to the right or to the left without disturbing the joint and causing it to leak. For this reason these pipes are connected with what are called *ball-joints*, fig. 88, that is, the end *a b*, of one of the pipes is turned into the form of a part of a sphere† and the other end into a corresponding concave form. It is known that a sphere will fit into a corresponding socket in any position; for example, an acorn in its cup or the bones at the hip or shoulder joints. If therefore the pipes are joined with such spherical or *ball-joints*, the lower end can be moved sideways several inches either way, and the joint would still be steam-tight if it was then firmly bolted together. Even after it is bolted together, it would have so much flexibility that the expansion and contraction of the pipes would not cause it to leak.

There is, however, still another difficulty. Although the lower end of the pipe, *o*, *o*, fig. 43, can, with a ball-joint above, be moved in any direction horizontally, yet if the pipe is too long or too short it is obvious such a joint would not permit it to be moved up or down. A joint with a flat surface, like that shown in fig. 87, would, however, permit such motion in the pipe without leaking. If, for example, the steam-pipe were ⅛ of an inch too short, it might be drawn down that distance, and if the upper joint were then screwed up it would still be steam-tight. In order, then, to get both vertical and lateral flexibility in the joints of the steam-pipes, a ring, *a*, *b*, fig. 89, is interposed between the pipes. One side of this ring is spherical and the other flat, so that the pipes can move either around the spherical part or slip up or down or sideways on the flat surface of the ring. In this way the pipes are flexible and adjustable in every direction, and for all kinds of motion caused by expansion, or which may be needed when the parts are put together. Sometimes the joints at one end only of the steam-pipes are made in this way, and the other is connected with a simple ball-joint.

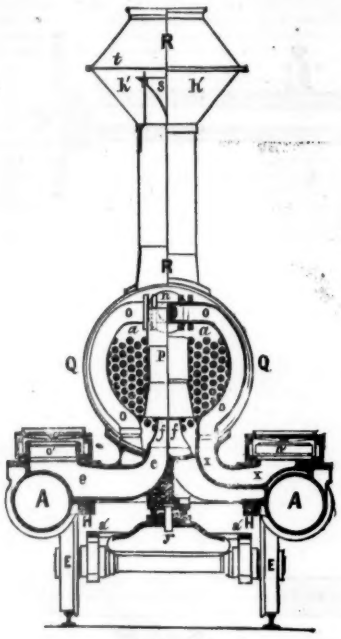

FIG. 43.

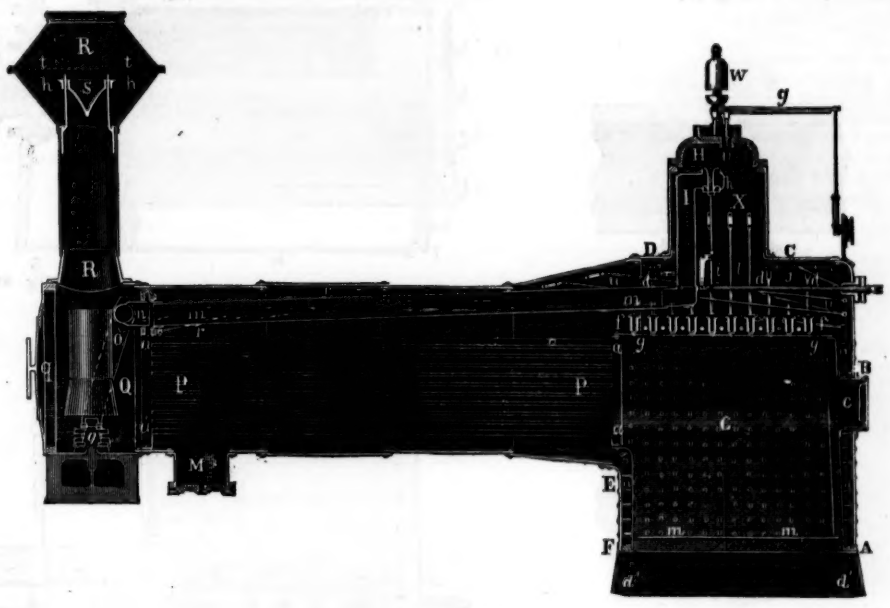

FIG. 44.

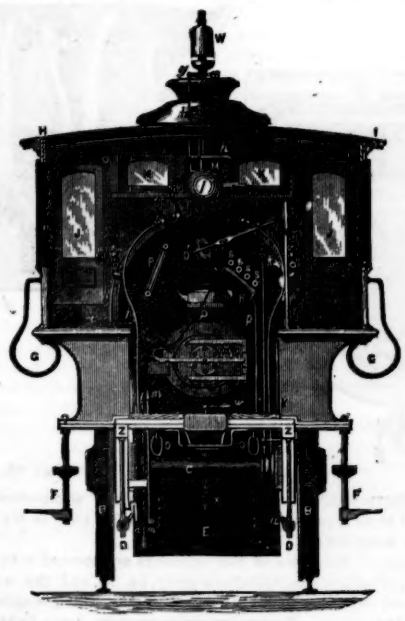

Fig. 71.

In designing these joints their form should be drawn with a radius, *c*, *d*, fig. 88, from one centre, *c*, so that the surface of the joint will form a part of a sphere. If they are drawn from two centres, as is sometimes done, it is obvious that the surface of the joint will not be a part of a sphere, and therefore will not have the requisite flexibility. The surfaces of the joints are carefully turned to the proper form, and then made steam-tight by scraping or grinding the two surfaces with emery and oil, and the pipes are then fastened together with bolts, *g*, *g*, fig. 89, and flanges, *f*, *f*, cast on the pipes.

QUESTION 153. *How are the exhaust pipes constructed?*

Answer. They are made of cast iron. When two nozzles are used they are generally cast together, as shown in fig. 90. When only one is used, the form of the pipes resembles somewhat that of an inverted letter A, as shown in fig. 91, so as to cover the two openings in the cylinders. The tops of the pipes have rings or bushings, *a*, *a*, fitted into them, which are held by set screws, *b*, so that they can easily be removed and others with larger or smaller openings be substituted. If the openings in the exhaust-nozzles are small, the steam must be discharged at a higher rate of speed, in order to exhaust all that is in the cylinders, than if the blast orifices are larger. Therefore, if the latter are reduced in size, the draft becomes more violent, but at the same time the *back-pressure* in the cylinder (which will be explained hereafter) is increased. It therefore becomes necessary to adjust the size of the blast orifices with the greatest care, so as to have them just small enough to produce the required draft and yet leave them as large as possible, so as to reduce the back-pressure. For these reasons, what are called *variable exhausts* are sometimes used. In these the blast orifice can be increased or diminished at pleasure, and thus regulated to suit the conditions under which an engine is working. A great variety of such devices has been used, but now nearly all have been abandoned for the simpler arrangement described, which is not variable when the engine is working.

*The cylinders are bored out perfectly true, and the pipes are then fastened together with bolts, *g*, *g*, fig. 89, and flanges, *f*, *f*, cast on the pipes.

†The dotted lines indicate what would be the form of the sphere if the pipe was solid instead of hollow.

PART X.

THE CYLINDERS, PISTONS, GUIDE-RODS AND CONNECTING-RODS.

QUESTION 154. *How are the steam cylinders constructed?*

Answer. They are made of hard cast iron, and have the steam and exhaust ports and the valve-seats cast with the cylinders. The harder the iron the better will the cylinders withstand the wear of the pistons and valves, but they must at the same time be made soft enough, so that after they are cast the inside can be bored out perfectly cylindrical, the ends turned off, the bolt-holes drilled, and the valve-seats planed smooth.

Fig. 92 represents a longitudinal section through the centre of the cylinder and steam-chest. Fig. 94 is a plan of the same parts with the cover of the steam-chest and the valve removed. The left-hand side of fig. 95 shows a transverse section through the centre *c*, *d*, fig. 92, of the cylinders, and the right side is a section through the steam pipe *G*. The same letters indicate like parts in three different views.

The cylinders of locomotives in this country are now universally placed on the outside of the wheels, as has already been described. In order to fasten them securely together and to the boiler, they are attached to what is called a *bed-plate* or *bed-casting*, *D*, *D*, figs. 94 and 95, which is placed between them. Some builders make this bed-casting in a separate piece, and the cylinders are then bolted to it on the outside, about at the dotted line *l*, *m*, fig. 95. Others cast one-half of it with each cylinder, as shown in our engravings, and then bolt them together at the line *i*, *j*, which is the centre of the engine. The bed-casting is also bolted to the smoke-box by the flanges *E*, *E*. The cylinders are bolted to the frame *F* with bolts *m* and *k*, fig. 95.

After the cylinders are bored out, and the ends turned off, *heads*, *A* and *B*, figs. 92 and 94, are fitted with steam-tight joints to each end. These heads are fastened with bolts and nuts, *a*, *a*, *a*, figs. 92 and 94, to flanges, *C*, *C*.

QUESTION 155. *How is the steam conducted to and from the cylinders?*

Answer. Two pipes or passages are cast in each cylinder, the one, *G*, *G'*, fig. 95, for admitting steam into the steam-chest, and the other, *H*, *H'*, for exhausting it from the cylinders. The one *G*, *G'* is called the *steam-passage*, and the other *H*, *H'*, the *exhaust-passage*. The steam-passage termi-